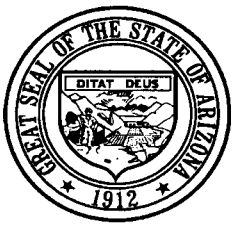
CHAPTER

7

Groundwater Quality Management Program



7.1 INTRODUCTION

Water quality is a component of the management of the water supply in the Pinal Active Management Area (AMA). The role of the Arizona Department of Water Resources (Department) in water quality relates to the impacts of water quality on available water supplies. Protecting and managing water quality maximizes the overall quantity of usable water, and matching the best use to the quality of water is a significant aspect of meeting the Department's water management objectives. This chapter defines the Department's role and authority in meeting groundwater quality management objectives during the third management period and addresses water quality impacts on the management of water supplies in the AMA.

Generally, the Department's responsibilities include enhancement of groundwater quality protection programs, assistance in the cleanup of contaminated areas, and assistance in matching water quality with the highest beneficial use. In the third management period, the Department will play a greater role in water quality issues because of increased responsibilities and funding for water quality management activities provided for in the 1997 Water Quality Assurance Revolving Fund (WQARF) Program reform legislation. Laws 1997, Ch. 287. Furthermore, the utilization of renewable supplies such as Central Arizona Project (CAP) water and treated effluent, as well as the designation of end uses for remediated groundwater, will play a larger role in water supply activities during the third management period.

Three sources of water comprise most of the supply in the Pinal AMA: CAP water, surface water from the Gila River, and groundwater. To a lesser extent, other sources of supply include treated effluent discharged from municipal wastewater treatment facilities, and surface water from the Santa Cruz River. All of these supply sources are directed toward meeting agricultural, municipal, and industrial water demand. At the present time, potable supplies for meeting municipal demand for drinking water rely exclusively on groundwater.

While the quality of most groundwater in the Pinal AMA currently meets state and federal drinking water standards, restrictions on the use of groundwater for drinking purposes have been imposed on a small number of wells due to concentrations of nitrates and fluoride. Based on the most current and available data, there are no major issues at the present time which affect or are affected by water quality in the AMA. However, the following areas of wide concern warrant attention.

Currently, there is insufficient information to support a reasonable determination of whether water supplies in the AMA are being adequately protected. Examples include:

1. A number of identified sites of groundwater contamination affecting domestic and municipal water systems may be the result of their proximity to agricultural activities. To date, the causes for contamination of these sites are undetermined, and any actual or potential linkage remains unsubstantiated.

2. The full extent of groundwater contamination in the AMA resulting from migration patterns underground, natural inflow-outflow trends, and cones of depression caused by concentrated groundwater pumping remains largely unknown. Likewise, the volumes of groundwater affected by contamination are unknown.

3. Abandoned wells and subsidence fissuring in the AMA may pose a risk of groundwater contamination by providing unrestricted access to aquifers, but no corroborating studies are known to exist.

In addition, the effects on groundwater quality as the result of direct use and recharge of imported renewable water supplies, such as CAP water, are largely unknown. Although a net increase in salts which

are deposited in soils and groundwater is expected, the potential impact of increased salt loading on natural salt balances as a result of importing renewable supplies has not been adequately studied. Even so, this impact is not expected to be a significant problem.

Managing and protecting the quality of Pinal AMA water supplies will help to ensure their future availability. During the third management period, the Department's regulatory authority will be used to enhance water quality protection programs that will facilitate the cleanup of contaminated areas and ensure that water sources are matched with their highest beneficial use. In 1997, the Department's regulatory authority and funding for water quality management activities increased with passage of the WQARF bill. In addition, the Department and the Arizona Department of Environmental Quality (ADEQ) have agreed to cooperate in programs to protect the quality and quantity of water supplies in the AMA during the third management period.

7.2 GOALS AND OBJECTIVES

The Department's goals and objectives for groundwater quality management for the third management period are complicated due to the Department's responsibility to achieve reductions in withdrawals of groundwater and to facilitate remediation of contaminated groundwater by implementing incentives for the use of remediated groundwater. The WQARF reform legislation of 1997 creates several incentives for the use of remediated groundwater. In response to the fact that many sites with groundwater contamination have not been cleaned up, the Legislature mandated incentives for remediated groundwater use which could result in a significant increase in groundwater withdrawals. These incentives to use remediated groundwater present a unique groundwater management problem because they may be in conflict with an underlying objective of the Groundwater Code (Code), which is to "achieve reductions in withdrawals of groundwater" to attain the management goal of each AMA.

The Department recognizes that the goal of remediating contaminated groundwater is an important one and intends to facilitate such remediation by implementing incentives for remediated groundwater use. However, as the agency entrusted with the responsibility of managing and conserving Arizona's long-term water supplies, the Department also has the responsibility to ensure that the minimum amount of groundwater necessary to achieve remedial action objectives is pumped and to ensure that where practicable new groundwater uses are not created and groundwater supplies are conserved. While the Department believes that it is possible to both achieve reductions in withdrawals of groundwater and provide incentives for the use of remediated groundwater, it recognizes that there is a delicate balance between the two responsibilities which will involve coordinated efforts between ADEQ and the Department to ensure that, on a case-by-case basis, no more groundwater is withdrawn than is necessary.

To implement its groundwater quality management challenge, the Department will "coordinate and confer" with ADEQ regarding "water plans, water resource planning, water management, wells, water rights and permits, and other appropriate provisions of [title 45] pertaining to remedial investigations, feasibility studies, site prioritization, selection of remedies and implementation of the [WQARF] program pursuant to title 49, chapter 2, article 5." A.R.S. § 45-105(B)(4)(c). To this end, the Department is in the process of creating a draft Memorandum of Understanding between the two agencies.

The Department's goals and objectives for groundwater quality management for the third management period are the following:

- to ensure that remediation of contaminated groundwater uses the minimal amount of groundwater necessary to facilitate the objectives of each remedial action project.

- to ensure that end uses of remediated groundwater minimize groundwater withdrawals and preferably have only minimal impacts on the groundwater resources in the AMA.

- to ensure that water quality considerations affecting Department programs that extend beyond the scope of the WQARF program are also addressed in order to preserve groundwater quality and quantity. Some of these considerations include well construction and abandonment standards, well spacing, assured water supply, recharge, and groundwater withdrawal permits.

Where remediated groundwater cannot be re-injected or recharged, the Department will emphasize replacing existing groundwater uses with remediated water and preventing new permanent uses which would not have occurred without the poor quality groundwater accounting and which would continue to rely on groundwater after the poor quality groundwater is no longer available.

Pursuant to the WQARF Program, the Department will respond to the highest ranked sites on the WQARF site registry. The Department's objectives are to ensure that remedial action projects are not an impediment to achieving the management goals for each AMA, and that cleanups are performed in a prudent and efficient manner from a water management perspective.

7.3 STATUTORY PROVISIONS

ADEQ is the agency primarily responsible for regulating water quality. The Department also has some limited responsibilities in this area. Statutory provisions pertaining to the Department's limited authority to regulate groundwater quality are discussed below.

The Code grants the Department authority to regulate groundwater. Under the Code, the Department has the following authority and responsibilities relating to water quality:

- "[T]he director may . . .[f]ormulate plans and develop programs for the practical and economical development, management, conservation and use of surface water, groundwater and the watersheds in this state, including the management of water quantity and quality." A.R.S. § 45-105(A)(1).

- "[T]he director may . . . [c]onduct feasibility studies and remedial investigations relating to groundwater quality and enter into contracts and cooperative agreements under § 104 of the comprehensive environmental response, compensation, and liability act [CERCLA] of 1980 (P.L. 96-510) to conduct such studies and investigations." A.R.S. § 45-105(A)(16).

- For the third management period, the director "shall, in cooperation with the department of environmental quality, include in each [management] plan an assessment of groundwater quality in the active management area and any proposed program for groundwater quality protection. Any such program shall be submitted to the Legislature for any necessary enabling legislation or coordination with existing programs of the department of environmental quality." A.R.S. § 45-566(A)(7).

- "[T]he director shall consult with the department of environmental quality on water quality considerations in developing and implementing management plans under this article." A.R.S.§ 45-573.

The WQARF legislation, as revised in 1997, expands the Department's role in water quality management. The Department's responsibilities and authority under WQARF, which will be explained in greater detail later in this chapter, include the following:

- "[T]he director of water resources, in consultation with the director of environmental quality, may inspect wells for vertical cross-contamination of groundwater by hazardous substances and may take appropriate remedial actions to prevent or mitigate the cross-contamination. . . ." A.R.S. § 45-605(A).

- "[T]he director [of water resources] shall notify an applicant for a permit or a person who files a notice of intent to drill a new or replacement well if the location of the proposed well is within a subbasin where there is a site [with existing or future groundwater contamination presenting a risk of vertical cross-contamination by the well]." The director is also required to adopt rules relating to vertical cross-contamination and new or replacement wells. A.R.S. § 45-605(E).

- "[T]he director of environmental quality and the director of water resources shall coordinate their efforts to expedite remedial actions, including obtaining information pertinent to site investigations, remedial investigations, site management and beneficial use of remediated water." A.R.S. § 49-290.01(C).

- The director of water resources may waive permits, approvals or authorizations if they "unreasonably limit the completion of a remedial action." A.R.S. § 49-290.01(A). The director of water resources may also waive any regulatory requirement under title 45 if the requirement conflicts with the selected remedy in a remedial action as long as the waiver does not "result in adverse impacts to other land and water users." A.R.S. § 49-290.01(D).

- "The department of water resources shall include in its management plans . . . provisions to encourage the beneficial use of groundwater that is withdrawn pursuant to approved remedial action projects. . . ." Laws 1997, Ch. 287, § 51. In order to encourage the beneficial use of remediated groundwater, "the department of water resources shall account for groundwater withdrawn pursuant to approved remedial action projects under CERCLA or title 49, Arizona Revised Statutes, consistent with the accounting for surface water" for purposes of determining compliance with management plan conservation requirements. Laws 1997, Ch. 287, § 51(B).

- "For each calendar year until 2025, the use of up to an aggregate of sixty-five thousand acre-feet of groundwater withdrawn within all active management areas pursuant to approved remedial action projects under CERCLA or title 49, Arizona Revised Statutes, shall be considered consistent with the management goal of the active management area as prescribed in section 45-576, subsection I, paragraph 2, Arizona Revised Statutes." Additionally, in the third management period, 50 percent of the total volume of groundwater withdrawn pursuant to remedial action projects and in excess of the aggregate volume of sixty-five thousand acre-feet shall be considered consistent with the management goal of the AMA. Laws 1997, Ch. 287, § 52.

- "The department of environmental quality and the department of water resources shall develop a method of sharing data, including cooperative data base development and integration between the departments, that will provide the departments with the information necessary to protect the resources of the state." Laws 1997, Ch. 287, § 53.

- "The directors of environmental quality and water resources shall enter into an agreement to coordinate the well inspection and remediation programs and to rank wells within an area of contamination according to each well's potential to act as a conduit to spread contamination and to determine the appropriate remedial action regarding the wells with a potential to act as a conduit, including well reconstruction, well abandonment or no action." Laws 1997, Ch. 287, § 54.

7.4 THE REGULATION OF GROUNDWATER QUALITY IN ARIZONA

To understand the Department's role in regulating groundwater quality, it is important to understand the broad framework of laws and programs impacting both groundwater quality and surface water quality. Because groundwater quantity and quality issues are so interrelated, ADEQ and the Department work together to prevent and mitigate groundwater quality and quantity problems. ADEQ has the lead role in protecting the state's groundwater and surface water quality, while the Department secondarily manages groundwater quality concerns. This section discusses the regulatory agencies responsible for administering laws impacting groundwater and surface water quality as well as the federal laws and state programs impacting groundwater quality and secondarily surface water quality.

7.4.1 Water Quality Regulatory Agencies

Water quality protection programs in Arizona are based on both federal and state law and are primarily administered by either ADEQ or the United States Environmental Protection Agency (EPA) Region IX. ADEQ has the responsibility to administer state water quality programs pursuant to state statutes and to administer federal water quality programs for which the EPA has delegated its authority to the state, sometimes referred to as state primacy. The EPA has the responsibility to administer federal water quality programs pursuant to federal statutes but delegates its authority to states where the state demonstrates that it can adequately administer the program and the federal statute provides for the delegation of authority to states.

ADEQ has authority pursuant to the Arizona Environmental Quality Act of 1986 (EQA) to set water quality standards and to regulate discharges that have the potential to impact the quality of groundwater by requiring that discharges obtain Aquifer Protection Permits (APPs). ADEQ has authority under the Clean Water Act (CWA) to set Arizona's surface water quality standards and to certify that discharges subject to federal permits do not violate state water quality standards.

EPA Region IX retains authority to administer the CWA National Pollutant Discharge Elimination System (NPDES) permits and the pretreatment program, while the United States Army Corps of Engineers, Los Angeles District, has authority to administer CWA permits for the discharge of dredge or fill materials in Arizona's waters. EPA Region IX also has authority to require groundwater monitoring and remediation in accordance with CERCLA.

7.4.2 Federal Laws Impacting Groundwater Quality

The Safe Drinking Water Act (SDWA) is the primary federal law regulating groundwater quality. In particular, it regulates drinking water, which includes groundwater. The CWA, which regulates surface water, also impacts groundwater quality. CERCLA and the Resource Conservation and Recovery Act (RCRA) impact groundwater management through the regulation of hazardous waste and sites contaminated by hazardous waste. Following is a brief overview of these federal laws and their impacts on the Department's water quality management.

7.4.2.1 Safe Drinking Water Act

The SDWA was enacted in 1974 to regulate drinking water. ADEQ has been delegated authority by the EPA to implement the SDWA and "to ensure that all potable water distributed or sold to the public through public and semi-public water systems is free from unwholesome, poisonous, deleterious, or other foreign substances and filth or disease causing substances or organisms." A.R.S. § 49-351(A).

There are two types of standards set by the SDWA: national primary drinking water regulations and national secondary drinking water regulations. National primary drinking water regulations may either be

primary Maximum Contaminant Levels (MCLs) or treatment technique requirements. Primary MCLs are the maximum permissible level of a constituent in a public water system and constitute the enforceable standard for safe drinking water. Treatment technique requirements set action levels for constituents such as lead and copper that cannot be directly detected or removed by water systems. National secondary drinking water regulations, referred to as secondary Maximum Contaminant Levels, set non-enforceable numeric standards for the aesthetic quality of the water, such as taste, odor, or color. Water with contaminants above the secondary MCLs are not typically expected to cause health problems. ADEQ has adopted the EPA MCLs as state Drinking Water Standards and has the authority to adopt more stringent standards as well.

Although the Department does not directly regulate drinking water quality, the presence of contaminants in groundwater does negatively impact water quality for municipal providers and poses significant water management issues for drinking water systems.

7.4.2.2 Clean Water Act

The CWA, first passed in 1972, is the comprehensive federal statute regulating surface water quality. The CWA contains six major elements: (1) the NPDES permit program, which regulates discharges of pollutants by any person to the nations waters and is designed to protect the chemical and biological integrity of the nation's waters; (2) technology-based effluent standards that apply to the quality of a discharge from a facility; (3) state ambient water quality standards; (4) dredge and fill permits, which are designed to protect the physical and biological integrity of the nation's waters; (5) oil and hazardous substance spill liability; and (6) federal grant programs for improvement of municipal water treatment.

Under the NPDES permit program, all point source dischargers of pollutants into "waters of the United States" must obtain a permit. The jurisdictional reach of the CWA extends to "navigable waters," which are defined as "waters of the United States, including the territorial seas." 33 U.S.C. § 1362(7). EPA and the Corps define "waters of the United States" to include interstate waters; waters which are used, were used in the past, or may be susceptible to use in interstate or foreign commerce; tributaries to such waters; the territorial sea and wetlands. 40 C.F.R. § 122.2; 33 C.F.R. § 328.3(a). A frequently cited definition of "waters of the United States" is:

> any waterway within the United States also including normally dry arroyos through which water may flow, where such water will ultimately end up in public waters such as a river or stream, tributary to a river or stream, lake, reservoir, bay, gulf, sea or ocean within or adjacent to the United States. *United States v. Phelps Dodge Corp.*, 391 F. Supp. 1181 (D. Ariz. 1975).

Based on this "tributary rule," the CWA has potential application to dry land which drains into a water of the United States. Additionally, the EPA interprets waters of the United States to include wetlands, areas susceptible to use as habitat by migratory wildfowl, and areas where industries engaged in interstate commerce discharge. 44 Fed. Reg. 32854, 32858 (June 7, 1979); 51 Fed. Reg. 41206, 41217 (Nov. 13, 1986). "Point source" means:

> any discernible, confined and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation or vessel or other floating craft, from which pollutants are or may be discharged. 33 U.S.C. § 1362(11).

"Pollutant" includes dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal and agricultural waste discharged into water.

33 U.S.C. § 1362(6). Based on the expansive definitions of "waters of the United States," "point source" and "pollutant," the jurisdictional reach of the CWA NPDES program is quite broad. The EPA has also implemented an NPDES storm water permit program that regulates municipal and industrial runoff which eventually discharges to waters of the United States.

NPDES permits that allow discharges to canals or river systems as a result of remedial projects or by wastewater treatment facilities are important to the Department's overall water management strategy. As a result, the Department provides input on related reports and draft NPDES permits that may impact the water management activities in the state. Furthermore, non-point source contamination of groundwater by such substances as nitrate, sulfate, and dissolved solids can render large volumes of groundwater unusable for many purposes and pose serious water management problems. Therefore, the Department monitors statutory and programmatic developments as well as permits and reports related to non-point source discharges under the CWA.

The CWA also provides for area-wide long-range planning processes to mitigate water quality control problems in selected areas which result from urban and industrial wastewater. Because such planning processes provide a comprehensive review of wastewater treatment and reuse options, the Department participates in such plans and amendments and provides technical assistance to local councils of government who administer the plans.

7.4.2.3 Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA and the Superfund Amendments and Reauthorization Act, commonly referred to as the federal Superfund program, authorize investigation and remediation of groundwater contaminated by releases of hazardous substances. Groundwater remediation may be required to comply with MCL standards, although less stringent standards may be approved by the EPA on a case-by-case basis through a technical waiver process. In Arizona, CERCLA establishes a comprehensive response program which is administered by ADEQ in cooperation with the EPA. The Department also plays an advisory role in this process.

Under section 105 of CERCLA, the EPA is required to annually update the National Priorities List of Superfund sites. The sites are proposed for inclusion on the list after being assessed as to the release of hazardous substances that threaten public health and the environment. Two significant components in the Superfund process are site investigation (Remedial Investigation) and evaluation of possible cleanup alternatives (Feasibility Study). During the Remedial Investigation, information is gathered to determine the general nature, extent, and sources of contamination at a site. Once the final cleanup plan has been selected, the EPA formalizes this decision by signing a "Record of Decision" (ROD). The ROD also contains a Responsiveness Summary which is the EPA's response to public comments on the Remedial Investigation, Feasibility Study, and Proposed Plan. Design and actual cleanup activities (Remedial Design and Remedial Action) can then proceed.

The Department regularly participates in the CERCLA program activities, primarily for sites located within AMA boundaries. The Department's concern at CERCLA sites is that any groundwater that is withdrawn and remediated be put to reasonable and beneficial use. The Department participates on CERCLA technical committees and serves in an advisory capacity for monitoring and extraction well installation, source control projects, and permitting.

7.4.2.4 Resource Conservation and Recovery Act

RCRA established a national hazardous waste management program in 1976. Under RCRA, hazardous waste permits are issued for the treatment, storage and disposal of hazardous wastes. Individual permits issued to these facilities specify design, performance and operational standards which include groundwater

monitoring. Hazardous waste facilities also undergo a closure process once operations are reduced or terminated. Moreover, corrective action may be required at treatment, storage and disposal facilities and may include groundwater monitoring.

ADEQ has been delegated authority for the implementation of RCRA requirements in Arizona. The Department's participation at RCRA sites is important for water management activities, particularly in regard to well siting, use permits, and end use issues.

7.4.3 ADEQ Programs that Impact Department Groundwater Quality Activities

The EQA (A.R.S. § 49-101, *et seq.*) established ADEQ and created a strong and comprehensive water quality management structure. ADEQ's programs that protect groundwater resources include water quality assessments, groundwater monitoring, pollutant discharge, permitting activities, and remediation activities. The following are selected water quality protection programs which fall under the jurisdiction of ADEQ and have a direct impact on Department activities.

7.4.3.1 Aquifer Water Quality Standards

Arizona's Aquifer Water Quality Standards (AWQSs) are the cornerstone of the state's groundwater protection program. Arizona has adopted the federal primary MCLs, established under SDWA, as numeric AWQSs. A.A.C. R18-11-406. These standards apply to aquifers classified and protected for drinking water use. Because all aquifers in Arizona are classified and protected for drinking water use, Arizona's AWQSs are enforceable standards for water quality in all of Arizona's aquifers. A.R.S. § 49-224(B).

ADEQ may reclassify an aquifer within an AMA, upon consultation with the appropriate Groundwater Users Advisory Council and upon conducting a public hearing, for a projected use other than drinking water if the identified aquifer is hydrologically isolated from the other aquifers or other portions of the same aquifer; water from the identified aquifer is not being used as drinking water; and the benefits to the public of the resulting water quality degradation outweigh the costs. A.R.S. § 49-224(c).

Arizona has also adopted narrative AWQSs to regulate pollutant discharges for which no numeric standards have been developed. Arizona's narrative AWQSs include the following: (1) a discharge shall not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health; (2) a discharge shall not cause or contribute to a violation of a surface water quality standard established for a navigable water of the state; and (3) a discharge shall not cause a pollutant to be present in an aquifer which impairs existing or reasonably foreseeable uses of water in an aquifer. A.A.C. R18-11-405.

7.4.3.2 Aquifer Protection Program

The most comprehensive ADEQ groundwater protection program is the APP system, established by the EQA and implemented by rule in 1989. An individual or general permit is required for any person who discharges or who owns or operates a facility that discharges a pollutant from a facility either directly into an aquifer or to the land surface or the vadose zone in such a manner that there is a reasonable probability that the pollutant will reach an aquifer. A.R.S. §§ 49-201(11), 49-241. Discharging facilities that require either an individual or general permit to operate include surface impoundments, solid waste disposal facilities, injection wells, land treatment facilities, facilities which add a pollutant to an assortment of salt formations, dry well or underground cave or mine, mine tailings piles and ponds, mine leaching operations, large septic tank systems, effluent recharge projects, point source discharges to waters of the United States and sewage or sludge ponds and wastewater treatment facilities. A.R.S. § 49-241(B). Classes or categories of facilities which are exempted from APP requirements are identified in A.R.S. § 49-250. General permits are issued by rule and individual permits must be applied for.

APPs require a demonstration that AWQSs are maintained and the Best Available Demonstrated Control Technology (BADCT) is applied. For individual APPs, compliance with AWQSs is measured at a designated point of compliance. BADCT requirements ensure that the greatest degree of discharge reduction is achieved through an evaluation of site-specific engineering, environmental, and economic criteria.

APPs may require compliance with best management practices (BMPs). BMPs are often site design techniques for the purpose of water quality protection. BMPs may be adopted for on-site facilities for urban runoff, storm sewers, silvicultural activities, and septic tank systems. Agricultural general permits require compliance with BMPs for nitrogen fertilizer application and concentrated animal feeding operations. ADEQ is required to monitor compliance with the established BMPs and to measure BMPs effectiveness.

Department staff receives and reviews all APPs for any impacts on Departmental programs and water management. In particular, the Department coordinates with ADEQ to review APP applications for potential harmful water quality impacts on groundwater conditions. Pursuant to A.A.C. R18-9-109, ADEQ advises the Department of each APP application received for a facility that is a recharge project or an underground storage and recovery project. One of the conditions for the issuance of an underground storage facility permit is that ADEQ must determine that the facility is not in a location which will result in pollutants being leached to the groundwater table so as to cause unreasonable harm. A.R.S. § 45-811.01(C). Facilities exempt from APP provisions may instead be required by the Department, in consultation with ADEQ, to meet other requirements to mitigate harmful water quality impacts to the aquifer.

7.4.3.3 Wellhead Protection Program

An important addition to Arizona's groundwater protection program has been the development of the Wellhead Protection Program which fulfills federal requirements of section 1428 of the SDWA by designating Wellhead Protection Areas around public drinking water systems. The Wellhead Protection Program is a voluntary program which encourages the protection of all wells, not just public drinking water system wells. Local entities that have the authority to control land use and exercise other management options can implement wellhead protection, therefore, encouraging the creation of local programs.

7.4.3.4 Reuse Permits

Reuse permits are issued to facilities which provide wastewater for reuse. A reuse permit specifies the amount of effluent to be reused and its chemical quality. ADEQ wastewater reuse rules (A.A.C. R18-9-701, *et seq.*) set the criteria for the use of treated effluent, or reclaimed water, for purposes such as agricultural irrigation, turf irrigation, and recharge. The current reuse rules prescribe numeric reclaimed water quality criteria and monitoring requirements for specific reuse applications. In general, these rules prescribe allowable limits for pH, total fecal coliform, turbidity, enteric viruses, and certain parasites. Reuse may be limited depending on the quality of source water and the intended use.

Wastewater reuse rules undergo periodic updating through the ADEQ's rule making process. The Department reviews any proposed changes to the wastewater reuse rules to ensure the protection of public health and groundwater supplies while maximizing the use of a significant renewable water supply. The Department evaluates effluent reuse permits issued by the ADEQ and encourages the use of treated effluent where appropriate.

7.4.3.5 Underground Storage Tanks

ADEQ'S Underground Storage Tank (UST) program was developed to ensure the proper operation of USTs and to prevent and remediate releases. Under state regulation and RCRA amendments, the UST program consists of notification requirements, technical standards for new and existing USTs, leak detection and closure criteria, corrective actions for remediation and financial responsibility demonstrations. Leaking USTs in a concentrated area can present detrimental impacts on groundwater quality and supplies.

The Department has the authority to issue poor quality groundwater withdrawal permits for water contaminated by USTs. The Department can provide guidance for UST site remediation projects to ensure the beneficial use of remediated water.

7.4.3.6 Water Quality Assurance Revolving Fund

The WQARF Program, sometimes referred to as the state Superfund program, was created as part of the EQA. WQARF monies are used to protect the waters of our state against hazardous substances, and may be used in conjunction with federal funds. Funds can be used for statewide water quality monitoring, health and risk assessment studies, and remediating hazardous substances which threaten the waters of the state. Mitigation of non-hazardous substances is also allowed under specified conditions. A.R.S. § 49-286. Each year, ADEQ develops a list of environmentally threatened sites which qualify for WQARF monies. Funds are used at those sites to mitigate existing contamination or to prevent further spread of pollutants which may threaten our water supplies. A priority list is developed by ADEQ based on such things as the degree of risk to the environment and other available funding sources.

Some of the key legislative changes made in the 1997 WQARF reform package include: establishment of a proportional share liability for cost allocation to responsible parties; creation of the neutral party arbitration process, with incentives to encourage early settlements and disincentives to responsible parties which do not enroll in the neutral party arbitration process; new ADEQ funding mechanisms designed to protect existing wells against migrating contamination from WQARF sites; the creation of a comprehensive WQARF site registry, which consolidates a number of separate lists which were previously used; the inclusion of petroleum releases in the WQARF Program under some circumstances; and increased flexibility in the selection of groundwater remedies.

ADEQ follows a process for management and cleanup of WQARF sites that consists of site identification and characterization, site prioritization, remedy selection, identification of end uses, implementation and monitoring, and closure. The criteria to be used in evaluation of response actions include practicability, risk, cost, and benefit. This process also includes a comparison of alternatives based on established statutory criteria, developing a Remedial Action Plan, providing public comment, and issuing a ROD. The Department of Water Resources will actively coordinate with ADEQ in the planning and implementation of groundwater cleanup actions under WQARF.

7.4.3.7 Water Infrastructure Finance Authority

In 1989, the Legislature created the Wastewater Management Authority to administer funds granted to the state pursuant to the SDWA. These funds, which required a 20 percent state match, were loaned to wastewater treatment systems in the state for assistance in meeting requirements of the SDWA. The ADEQ made loans for this purpose from monies in the ADEQ wastewater treatment revolving fund.

In 1997, this administrative body was amended by the Legislature and renamed the Water Infrastructure Finance Authority (WIFA). The authority for WIFA was expanded to make loans available to drinking water systems in addition to wastewater treatment systems for assistance in meeting requirements of the

SDWA. The state funding source was also changed so that monies made available to these systems are now derived from the drinking water revolving fund. The Department participates on the advisory board which oversees the WIFA and has an interest in viability of water systems and SDWA compliance.

7.4.4 Department Programs Related to Groundwater Quality

The Department protects groundwater quality by considering groundwater quality issues in its permitting process and water quantity management programs. As a result of the WQARF reform legislation of 1997, the Department has increased its responsibility in the program to coordinate and provide assistance to WQARF activities in Arizona. Among other things, the bill provides for:

- annual funding for Department WQARF activities;
- database development and coordination with ADEQ;
- groundwater withdrawn pursuant to certain cleanups to be accounted for in the same manner as surface water for the purpose of determining compliance with conservation requirements,
- amendment of the Assured Water Supply Rules (AWS Rules);
- active involvement by the Department in all phases of site assessment, remediation, management, operation, and planning strategies;
- a WQARF Advisory Board on which the Department has a seat; and
- a well inspection program through which wells that are contributing to vertical cross-contamination may be identified and modified.

The Department's existing permits and programs which involve groundwater quality issues as well as its new programs for groundwater quality protection based on the WQARF legislation are discussed in the following section.

7.4.4.1 Poor Quality Groundwater Withdrawal Permits

Appropriate use of poor quality groundwater conserves the existing supply of potable groundwater. The Department issues poor quality groundwater withdrawal permits to allow the withdrawal of groundwater which, because of its quality, has no other beneficial use at the present time. A.R.S. § 45-516. Withdrawal permits are issued by the Department, and the withdrawal must be consistent with the AMA management plan. Permits are usually issued in conjunction with CERCLA, WQARF, or leaking UST sites for pump and treat operations. To increase the appropriate uses of poor quality groundwater during the third management period, the Department will continue to encourage matching poor quality groundwater with beneficial uses within the AMA.

7.4.4.2 Assured Water Supply

The Assured Water Supply Program (AWS Program) is a consumer protection program that ensures that new subdivisions have a secure supply of water with adequate quality for at least 100 years. Pursuant to A.R.S. § 45-576, before land may be subdivided, the developer of the property must either obtain a Certificate of Assured Water Supply (Certificate of AWS) for the subdivision from the Department or must establish the development as a customer of a municipal water provider that the Department has designated as having an assured water supply.

Pursuant to rules governing the AWS Program set forth at A.A.C. R12-15-701, *et seq.*, in order to establish an assured water supply, the applicant must prove that a supply of water is physically, legally and continuously available for the 100-year period to meet the demands of the development that will be the subject of the Certificate of AWS, or in the case of a designation, to meet current and committed demands of the water provider for the 100-year period. The applicant must also establish that projected water use will be consistent with achievement of the management goal for the AMA and that the applicant has the

financial capability to construct the physical facilities necessary to serve the development. In addition, the applicant must establish that the water supply pledged for assured water supply purposes is of adequate quality.

In assessing the quality of a groundwater supply pledged for assured water supply purposes, the Department works closely with ADEQ to determine whether the groundwater supply meets ADEQ standards for the purposes for which the water is pledged. If the groundwater is not of adequate quality, the applicant may need to find alternative water sources or to expend additional resources treating the groundwater to meet the ADEQ standards.

7.4.4.3 Underground Water Storage and Recovery

Underground water storage, also known as recharge, will play an important role in achieving the Pinal AMA's water management goal. Recharge enables CAP water that is currently not used directly to be stored. In addition, recharge of effluent can be used as a tool to allow more complete use of that resource.

The underground water storage program is administered by the Department. Permits must be obtained from the Department prior to undertaking recharge activities. The Department coordinates closely with ADEQ to ensure that underground water storage does not adversely impact existing aquifer water quality and does not cause movement of existing groundwater contamination. If effluent is stored underground, the applicant must obtain an APP from ADEQ, in addition to the underground storage permits required from the Department.

7.4.4.4 Well Spacing/Impact Analysis

A.R.S. § 45-598 and the Department's temporary Well Spacing and Well Impact Rules are in place to prevent unreasonable damage to surrounding wells, as well as land and water users, due to new wells and new withdrawals of groundwater in an AMA. Specifically, these laws require well impact studies to evaluate the potential for new non-exempt wells and new withdrawals to damage land and other water users, particularly existing wells. The Department conducts the impact studies for wells with a maximum discharge of 500 gallons per minute or less. For wells with a maximum discharge rate exceeding 500 gallons per minute, the permit applicant must submit a hydrological study of projected water level declines due to the operation of the proposed well. The study must also assess adverse impacts from the migration of poor quality groundwater. The well permit application may be denied if the Department determines that the proposed well would cause an unreasonable and adverse impact on surrounding wells, additional regional land subsidence, or migration of poor quality groundwater.

7.4.4.5 Well Construction and Abandonment Requirements and Licensing of Well Drillers

If wells are not constructed, sealed, or abandoned properly they can act as conduits for contaminant flow from the surface to groundwater or between aquifers. Improperly constructed wells can contribute to groundwater contamination. The Department's rules governing well construction, abandonment, and driller licensing, set forth in A.A.C. R12-15-801 *et. seq.*, are summarized below.

- Minimum well construction and abandonment requirements prevent entry of fluids at and near the surface and minimize the possibilities of migration and inadvertent withdrawal of poor quality groundwater. These requirements also prohibit the use of hazardous materials in the construction of wells.

- Installation, modification, abandonment, or repair of wells in Arizona must be performed by a driller licensed by the Department. The licensing procedure includes the administration of written

examinations to test the applicant's knowledge of state regulations, hydrologic concepts, and well construction principles and practices.

- Disposal site restriction prevents the use of wells as disposal facilities for any material that may pollute groundwater.

- Special standards may be required by the Department if the minimum well construction requirements do not adequately protect the aquifer or other water users.

- Open wells must be capped with a water-tight steel plate.

- Except for monitor and piezometer wells, no well shall be drilled within 100 feet of any septic tank system, sewage disposal area, landfill, hazardous waste facility or storage area, or petroleum storage areas and tanks, unless authorized by the director.

Wells drilled prior to the enactment of the well construction rules (effective March 5, 1984) were not required to be constructed in accordance with minimum well construction standards. If a pre-rule well is replaced or modified, however, the new or modified well must meet the current well construction standards. A.R.S. § 45-594.

7.4.4.6 The Department's Role in the WQARF Program

The Department's involvement in groundwater remediation has been redefined as a result of the Groundwater Task Force, which conducted an extensive series of stakeholder negotiations designed to promote groundwater cleanup and groundwater quality management activities of remedial sites. Involvement in this development process was widespread and representative of a varied group of private and public interests.

7.4.4.6.1 Department Activities in the WQARF Site Cleanup and Management Process

ADEQ's WQARF site cleanup and management process and the Department's role in that process are described in the following discussion.

Site Identification and Characterization

Existing WQARF sites have been identified and are being managed by ADEQ. Additional sites may be identified in the future based on a preliminary investigation by ADEQ to determine the potential risk to public health, welfare, or the environment. The Department will further assist ADEQ in this process by providing resource data which include well location and pumpage records, water rights information, and any other appropriate data recorded by the Department.

Characterization of sites is important because the nature and extent of contamination must be understood before remedies can be selected and implemented. An important part of site characterization is an evaluation of how contamination impacts current and future groundwater uses. The Department's role may include such activities as site inspections and evaluations, review of investigations, field work such as well inspection and water quality sampling, identification of potential water management issues, and any other characterization as appropriate. Department computer models may be useful in characterizing groundwater flow patterns.

Site Prioritization

The results of the preliminary investigation will be used by ADEQ for site scoring using a method to be established in rules adopted by ADEQ. The completed preliminary investigation will be used by ADEQ to either make a determination of no further action on a site, or to prepare the site for inclusion on the Site Registry. In this latter case, a Site Registry report is prepared containing a description of the site, with its geographical boundaries indicated, and a score in accordance with the site scoring method to be established in rules and adopted by ADEQ. The Department will assist ADEQ by sharing pertinent water resource information as described in the previous subsection.

Remedy Selection

ADEQ has established a list of response actions to be considered when managing a site. Based on the potential impact on current and future water uses, a potential remedy must be evaluated and designed. Each remedy is site-specific. The Department will assist in defining potential remedies to ensure the remedy is consistent with Department management plans and sound groundwater management practices that are publicly acceptable. Ultimately, the Department's level of assistance will vary based on the remedy selected. Possible remedies are discussed below.

- Plume Remediation

Plume remediation, or aquifer restoration, means achieving appropriate water quality standards for groundwater throughout the affected area. Source control and monitoring will likely be essential elements of this strategy. This remedy may be more effective for smaller plumes which can be remedied within reasonable time frames.

- Physical Containment

Physical containment refers to an approach that contains contaminants within defined boundaries. This strategy could consist of plume control and coordination of groundwater pumpage and recharge to ensure that contamination is confined within a defined area. Source control and monitoring are also likely elements of this strategy. Physical containment may be appropriate where potable water supplies are threatened by contaminant migration and where containment is technically feasible, but it may require extensive groundwater management to implement.

- Controlled Migration

This strategy aims to control but not necessarily contain migration of contaminants. Source control and monitoring are likely elements of this strategy. Control of contaminants can include control and/or coordination of pumpage that affects contaminant migration and any other measures taken to control contaminant migration. Controlled migration may be appropriate for larger plumes which cannot be practically remedied or contained.

- Source Control

Source control is reduction of continuing contaminant sources such as soil contamination or areas of high concentrations of volatile organic compounds (VOCs) or other contaminants. Dense non-aqueous phase liquids, which are contaminants (such as VOCs) of such high concentrations that they are not dissolved in groundwater but exist as free phase liquids, are an example of contaminant sources. Source control is a remedial action that often results in the highest volume of contaminants removed per unit cost.

This strategy employs controlling the pollutant at the source to ensure that aquifer contamination does not continue on due to uncontrolled contaminant releases. Monitoring is a likely component of this strategy. Source control can include, but is not limited to, the mitigation of sorbed or free phase contaminants, pumpage of groundwater to contain or control significant sources of contaminants, and the removal of contributing contaminant sources.

- Monitoring

The monitoring remedy involves monitoring instead of other remedy options. Monitoring sites for water quality and groundwater levels is important to determine the extent of contamination and the effectiveness of remedial activities. The incorporation of computer groundwater models may be used to predict contaminant movement, to monitor well locations, and to develop contingency plans for more aggressive remedies, if necessary.

- No Action

This alternative consists of taking no action at a site. This strategy is normally included as a baseline condition for comparison purposes, but may be a viable alternative in limited cases. Generally, this alternative would only be chosen for sites that are geographically isolated from populated areas, do not pose a significant threat to water supplies, or would be used for comparative purposes to other sites.

Identification of End Uses

The Department is committed to the beneficial use of groundwater withdrawn and treated at WQARF sites, along with other areas that have degraded groundwater quality, and will assist ADEQ with the identification and facilitation of designated end uses for remedial projects. These end uses should be consistent with those determined for existing sites as well as the development of new end uses to match the intended use.

Implementation and Monitoring

The implementation and monitoring phase of a site activity includes construction, startup, monitoring, operation and maintenance, and any other necessary activities. The Department will assist ADEQ in this phase through the following activities: field work, review of groundwater analyses, appropriate groundwater and assured water supply accounting, and any other appropriate activities.

Site Closure

ADEQ must certify that site goals have been attained in order to discontinue cleanup activities. Department staff will assist in evaluation of sites and certification of site closure. The Department will assist and may need to identify alternative water sources to replace remediated water when sites are closed.

7.4.4.6.2 Department Policies for WQARF Site Cleanup and Management

In general, site plans should be consistent with the management goal of the AMA in which the site is located. A.R.S. §§ 49-282.06(F); 45-105(B)(4)(c). Therefore, the Department will implement policies during the third management period for the management and cleanup of remedial sites in cooperation with ADEQ. These policies will ensure that AMA goals are addressed when remedial actions are planned. The Department supports proposed remedial projects when they are appropriate, but believes that remedies must make sense from a groundwater management perspective. The principles which will be used to formulate these policies are described below.

Water should be used consistent with water allocation concepts in Title 45

This policy requires that entities using water withdrawn pursuant to cleanups, whether under CERCLA, WQARF, RCRA, voluntary, or other sites, possess appropriate authorities for the use of groundwater (such as permits or water rights).

The Department supports source control cleanups to protect water sources

Source control, which controls pollution at its source, can be the most cost-effective and practicable approach to cleanups. Many wells have been rendered unsuitable for potable use due to migrating contamination. Source control projects to protect wells that are threatened by contaminant migration are generally supported by the Department. Pollution prevention is also a significant component of mitigating contaminant migration.

Any groundwater withdrawn must be put to reasonable and beneficial use

Reasonable and beneficial use of groundwater withdrawn is a policy that applies to all cleanups. Any withdrawals of 100 acre-feet or less annually may qualify for de minimis status and be exempted from beneficial use requirements, but the Department will evaluate de minimis exemptions from this policy on a case-by-case basis. In the case of leaking UST sites, the Department generally exempts sites that annually pump less than 10 or 15 acre-feet.

Contaminated groundwater represents a resource that will be important in the future

Even if groundwater is contaminated, it represents a resource that can be used for both potable and non-potable uses. Potable uses must meet the state AWQSs and federal Drinking Water Standards which govern public consumption of potable water. ADEQ and the Arizona Department of Health Services intend to develop end use standards for non-potable uses that, if implemented, will make large volumes of groundwater usable again. The Department will cooperate in the development of non-potable end use standards and will develop policies for appropriate end uses based on the new standards.

Containment remedies that involve massive groundwater withdrawals to achieve regional groundwater flow control are generally inappropriate and will not be supported by the Department

In some cases, massive groundwater withdrawals of uncontaminated or only slightly contaminated water may be considered to control migration of contaminant plumes or for other purposes. In general, the Department considers these kinds of proposed remedies to be wasteful of groundwater and not very cost-effective.

7.4.4.6.3 Statutory Mandates for the Department's Involvement in the WQARF Program

The 1997 WQARF reform legislation mandates that the Department implement certain water quality programs and provides for expanded Department involvement in water quality management. New Department programs and responsibilities based on the 1997 WQARF reform legislation include the following:

Remediated Groundwater Incentives

The WQARF reform legislation of 1997 directs the Department to include in the management plans developed pursuant to A.R.S. § 45-566 (the Third Management Plans) provisions to encourage the beneficial use of groundwater that is withdrawn pursuant to approved remedial action projects under CERCLA or Title 49, Arizona Revised Statutes. Laws 1997, Ch. 287, § 51(A).

- Remediated Groundwater Incentive for Conservation Requirement Accounting

In order to encourage the beneficial use of remediated groundwater, the Legislature specifically mandated:

> In determining compliance with applicable conservation requirements adopted pursuant to sections 45-566, 45-567 and 45-568, Arizona Revised Statutes, the department of water resources shall account for groundwater withdrawn pursuant to approved remedial action projects under CERCLA or title 49, Arizona Revised Statutes, consistent with accounting for surface water.

Laws 1997, Ch. 287, § 51(B).

- Remediated Groundwater Incentive for Assured Water Supply Accounting

In addition, the WQARF reform legislation of 1997 directs the Department to consider specified amounts of groundwater withdrawn pursuant to approved remedial action projects as consistent with the management goal of the active management area from which it is withdrawn for purposes of the Department's AWS Program. Laws 1997, Ch. 287, § 52. The Legislature mandated that:

> For each calendar year until 2025, the use of up to an aggregate of sixty-five thousand acre-feet of groundwater withdrawn within all active management areas pursuant to approved remedial action projects under CERCLA or title 49, Arizona Revised Statutes, shall be considered consistent with the management goal of the active management area.

Laws 1997, Ch. 287, § 52(A).

Once the aggregate volume of 65,000 acre-feet of remediated groundwater use by all users in all active management areas is reached in a year, the use of an additional amount of remediated groundwater is consistent with the management goal of the active management area based on a sliding scale. In the third management period, fifty percent of the total volume withdrawn in excess of the 65,000 acre-feet will be consistent with the management goal. Laws 1997, Ch. 287, § 52(B). By the year 2025, the remediated groundwater incentive for assured water supply accounting decreases to zero.

A municipal provider must apply for a remediated groundwater accounting for an assured water supply determination prior to January 1, 2010. The amount of groundwater determined to be consistent with the management goal cannot exceed the amount that the municipal provider is legally obligated to withdraw or use and does not extend beyond 2025. Laws 1997, Ch. 287, § 52(C).

Annual groundwater withdrawals of 250 acre-feet or less that are withdrawn pursuant to an approved remedial action project shall not be debited against the water provider's assured water supply mined groundwater account and shall not be subject to a replenishment obligation. The water provider must notify the Department of its compliance with the exemption. Annual withdrawals of 250 acre-feet or less of remediated groundwater will not count against the 65,000 acre-feet per year total volume. Laws 1997, Ch. 287, § 52(E).

- Coordination with ADEQ in Evaluating Proposed Remedial Actions

Pursuant to A.R.S. § 45-105(B)(4)(c), the Department is required to actively coordinate and confer with ADEQ in evaluating proposed remedial actions to provide ADEQ with information regarding water resource considerations. The Department will coordinate and confer with ADEQ *prior to* ADEQ's approval or denial of a proposed remedial action project. Once a remedial action project is approved by ADEQ or the EPA pursuant to CERCLA or Title 49, A.R.S., the Department will account for remediated

groundwater in accordance with Laws 1997, Ch. 287, § 51 and 52. Among other things, the Department will consider the following factors relating to proposed remedial actions in its recommendations to ADEQ:

- Volume of remediated groundwater to be withdrawn

The Department will encourage remedial actions that use the least amount of groundwater necessary to facilitate a project's goal and will discourage remedial actions that are not prudent and efficient from a groundwater management perspective.

- End uses to which remediated groundwater will be put

The Department will encourage end uses that minimize groundwater withdrawals and that are consistent with the planned depletion goal because they will maximize the quantity and quality of groundwater available for other uses. Where remediated groundwater cannot be practicably or cost-efficiently re-injected or recharged, the Department will encourage replacing existing groundwater uses with remediated groundwater and preventing new permanent uses which would not have occurred without the incentive to use remediated groundwater and which would continue to rely on groundwater after the remediated groundwater is no longer available.

While individualized circumstances will be evaluated on a case-by-case basis, generally, the Department's beneficial end use preferences are the following, which are listed in order from the most to least preferred and based on the impact on the AMA's management goal and the amount of groundwater in storage:

Neutral to local aquifer

a. Re-inject or recharge in the same local area.
b. Replace existing groundwater uses in the same local area.

Neutral to groundwater basin

c. Re-inject or recharge in the same AMA.
d. Replace existing groundwater uses in the same AMA.

Reduce groundwater in storage

e. Replace existing non-groundwater uses in the same AMA.
f. Beneficial uses of water for new purposes.
g. Artificial wetlands or artificial lakes.
h. Dispose to the sewer (unless the resulting effluent is re-injected, recharged, or replaces an existing groundwater use).

- Achievement of maximum beneficial use of waters and viability of proposed remedial action

Remedial actions must assure the protection of public health and welfare and the environment; to the extent possible, provide for the control, management, or cleanup of hazardous substances so as to allow the maximum beneficial use of the waters of the state; and be reasonable, necessary, cost-effective, and technically feasible. A.R.S. § 49-282.06(A).

- Consistency with Title 45

Groundwater withdrawn pursuant to an approved remedial action must be withdrawn and used consistent with Title 45, Arizona Revised Statutes.

Well Inspection, Modification or Replacement

The Department is required by the 1997 WQARF legislation to develop rules for well inspections. An evaluation of the extent of the cross-contamination problem will be performed by the Department in cooperation with ADEQ and other stakeholders.

Construction of New Wells in and Near WQARF Sites

The 1997 WQARF legislation mandates that the Department ensure that new or replacement wells in areas of known groundwater contamination are constructed in such a manner that cross-contamination does not occur. Department staff will screen Notices of Intent to Drill that are submitted to ensure that wells are properly constructed. The Department intends to establish policies and procedures to implement this directive, including procedures to effectively communicate with well owners and drillers.

Abandonment of Wells in and Near WQARF Sites

Department staff will review and evaluate Notices of Intent to Abandon to ensure that abandonment of wells is done in accordance with Department rules and that potential for cross-contamination is minimized.

7.5 WATER QUALITY ASSESSMENT

A water quality assessment must be included in management plans pursuant to the Code. The assessment provides an overview of water quality concerns in the Pinal AMA. The following section discusses goals and objectives of the assessment, water quality of renewable and groundwater supplies, the constituents of concern in the AMA and their impact on water management, and specific contamination areas in the AMA.

7.5.1 Assessment Goals and Objectives

The primary goal of the Third Management Plan's Water Quality Assessment is to provide a general evaluation of groundwater and surface water quality conditions in the Pinal AMA and to identify the interface of water quality concerns with the regional water supply. The impact of water quality on water resource management has become more important in recent years due to such factors as stringent water quality standards, conjunctive use of water supplies, groundwater management at remediation sites, and increasing levels of public concern.

The municipal, agricultural, and industrial sectors have distinctive demand patterns and requirements for water quality. For example, state law prohibits direct use of treated effluent for potable use, but treated effluent is used for turf irrigation, agricultural irrigation, cooling towers, and groundwater recharge. Water high in total dissolved solids (TDS) may be inappropriate for agricultural irrigation but may be usable for some industrial applications. Conversely, water high in nitrate could provide a good end use for agriculture, but does not meet potable standards. During the third management period, the Department will evaluate the matching of water quality characteristics with appropriate end uses while ensuring compliance with applicable laws and rules for each end use.

7.5.2 Renewable Water Supplies

Renewable water supplies include non-CAP surface water, CAP water, and effluent. The quality of these waters is discussed in this section.

7.5.2.1 Surface Water Other Than CAP

Most surface water in the Pinal AMA that is not supplied by the CAP is supplied by the San Carlos Irrigation Project, which comes from the Gila River. Other surface water is diverted from the Santa Cruz River by individual landowners with surface water claims or rights to waters in that river.

Surface water quality in the Pinal AMA is generally good. The quality of surface water diverted from the Gila and Santa Cruz rivers is suitable for irrigating the types of crops grown in the AMA without detrimental effects on production. San Carlos Irrigation Project surface water typically contains TDS levels between 500 and 600 milligrams per liter (mg/l). TDS concentrations are generally a good indicator of overall water quality. The quality of surface water in the Santa Cruz River is unknown. Because the Santa Cruz River tends to flow intermittently, depending on the rate of storm runoff, releases from wastewater treatment facilities in Tucson, and tailwater runoff from irrigated fields near Marana, the quality of this water is variable and TDS concentrations probably tend to be higher. At the present time, nearly all surface water entering the AMA is diverted for agricultural irrigation or turf watering purposes.

Other streams in the Pinal AMA are also ephemeral and are usually associated with washes that drain overland flows following heavy local rains. Because the volume of flow in these streams is sporadic and typically results from flooding, the direct use of this water is limited. Although relatively few surface water quality samples have been taken from stormwater runoff and analyzed, water from this source often contains bacteria, parasites, and/or viruses.

7.5.2.2 Central Arizona Project Water

The largest source of renewable water supply in the Pinal AMA is CAP water which is diverted from the Colorado River in an open canal. With appropriate treatment, the quality of CAP water is acceptable for most uses.

TDS concentrations in CAP water vary depending on the location within the CAP canal system. Seasonal data for TDS levels at various mileposts along the CAP aqueduct from 1991 through 1994 were obtained from the CAP. The seasonal data for TDS concentrations during this period at the Coolidge milepost ranged from approximately 480 mg/l to 700 mg/l. More information about levels of TDS is contained in section 7.5.4.3 of this chapter.

7.5.2.3 Effluent

Effluent is defined by A.R.S. § 45-101(4) as "water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated pursuant to A.R.S. §§ 49-361 and 49-362. Such water remains effluent until it acquires the characteristics of groundwater or surface water." Sanitary sewers are comprised of any pipe or other enclosed conduit that carries any waterborne human wastes from residential, commercial, and industrial facilities. A.R.S. § 45-101(8). To establish wastewater reuse options, wastewater reuse rules are developed by ADEQ. Wastewater discharges require an NPDES permit to ensure that water quality parameters are being met.

Currently, nearly all effluent treated at municipal wastewater treatment plants in the Pinal AMA is used for agricultural irrigation or turf watering purposes. A small amount of effluent is stored by the Town of Florence pursuant to an underground storage permit.

In the future, constructed wetlands may be developed to further enhance the treatment of effluent and pre-treat water prior to recharge or reuse. Vegetation and microbial activity in wetlands as well as filtration of effluent through the vadose zone (soil aquifer treatment) improves the quality of water containing high concentrations of nitrate and organic carbon. Constructed wetlands are occasionally used as a treatment for

lower quality surface waters and agricultural return flows. Wetland projects are also being evaluated as enhanced treatment for effluent discharges to meet potentially more stringent NPDES permit requirements. Wetlands also enhance wildlife habitat and serve as an educational and recreational resource for the community.

7.5.3 Groundwater Supplies

Groundwater is one of the most important sources of water in Arizona. Most of the groundwater supplies in the Pinal AMA are of acceptable quality for most uses. Although not a present concern, there is a potential for migration of contaminants into aquifer systems, since many areas of the AMA are projected to remain dependent on groundwater pumping. The Department's role in managing potential contaminant migration is through involvement in site-specific and non site-specific water quality management.

Groundwater that has been degraded has limited beneficial uses due to chemical, biological, or radiological contamination and may have high treatment and delivery costs associated with its use. Despite these limitations, the Department considers poor quality groundwater to be a valuable resource for future water management and encourages appropriate uses of this water supply. Matching the highest beneficial use with poor quality groundwater is an important aspect of water management. Frequently, poor quality groundwater is remediated and re-injected into the aquifer because it is not economically feasible to convey the treated water to a location for a higher beneficial use.

The Central Arizona Groundwater Replenishment District, the Arizona Water Banking Authority, and other entities are actively pursuing recharge of excess CAP water within the Phoenix, Pinal, and Tucson AMAs. The impacts of CAP water recharge on existing groundwater quality are not fully understood. Recognizing that there may be groundwater quality impacts resulting from surface water recharge, the EPA requires states to develop a rule for groundwater under the influence of surface water. ADEQ has proposed a rule (A.A.C. R18-11-405), currently under public review, which would require that groundwater, under the direct influence of surface water withdrawn from recharge facilities, undergo more extensive treatment than groundwater.

7.5.4 Groundwater Constituents and Their Impacts on Water Quality Management

The management of water resources requires an understanding of how water quality impacts aquifer conditions and potential uses. Drinking water quality regulations are developed to ensure that the intended use will not have harmful impacts on human health. The Department and ADEQ evaluate water quality based on ADEQ's numeric and narrative AWQSs as well as the EPA's MCLs and secondary MCLs, commonly expressed as mg/l or micrograms per liter (µg/l). Appendices 7A and 7B provide a more detailed listing of primary and secondary MCLs for selected VOCs, pesticides, inorganic metals, radiochemical, and other selected contaminants.

The following sections briefly describe the impact of selected constituents on groundwater management and public health. ADEQ's Arizona Water Quality Assessment was used as a reference to describe the limitations on uses, present and planned remedial activities, and potential uses for poor quality groundwater for each constituent.

For each constituent, a corresponding map is provided which displays available water quality data for well locations sampled in the Pinal AMA since 1990. Well sites that produced test results within acceptable water quality standards are displayed in addition to those well locations which exceeded standards. The groundwater quality maps developed for the constituents depicted on these maps were the result of an interagency effort between the Department and the ADEQ. An interagency team retrieved and analyzed data from a variety of sources including the Department's Registry of Groundwater Rights and

Groundwater Site Inventory databases, the ADEQ Groundwater Quality database, and a number of WQARF site project reports.

Other ADEQ databases, such as the Underground Storage Tank and Drinking Water Quality databases, were not used because they either did not have compatible well registration identification numbers from which to compare each agency's well information or they contained non-point source information which cannot be assigned to a specific location such as a well. Consequently, the groundwater quality maps depicted in this section are a product of the practical information available that is compatible with the Department's well identification system and from which both agencies had a high level of confidence in the data presented. The groundwater quality maps provide a general overview of water quality conditions within the AMA. Other reports which are published by the ADEQ may contain additional data which are not reflected on these maps.

7.5.4.1 Nitrate

Nitrates are salts formed from nitrogen compounds and are one of the most common groundwater contaminants detected. Low nitrate concentrations in groundwater may originate from natural sources such as organic acids. Elevated nitrate levels are generally attributed to industrial sources, wastewater treatment plants, septic tanks and leach fields, and agricultural fertilizers.

Water containing high levels of nitrate-nitrogen cannot be delivered as a drinking water supply unless it is equal to or reduced below the MCL of 10 mg/l. Adults can tolerate high levels of nitrate-nitrogen, although water containing more than several hundred mg/l can cause gastrointestinal irritation. Water that contains nitrate in concentrations in excess of the MCL can be harmful to infants. Nitrate may also be harmful to livestock at levels exceeding several thousand milligrams per liter.

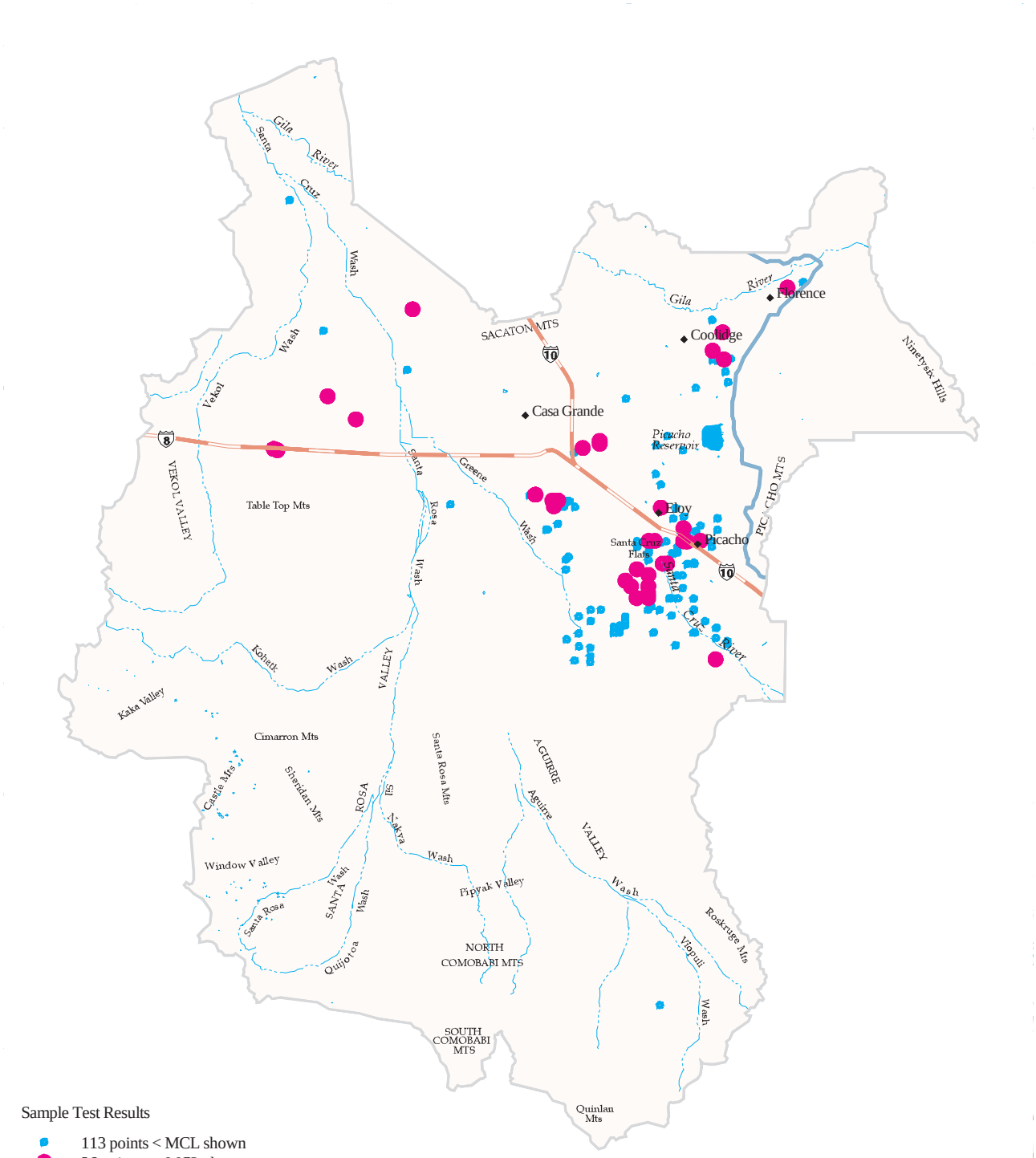
Nitrate stimulates plant growth and is typically regarded as a desirable constituent under most agricultural and turf irrigated conditions. For this reason, effluent is often sought as a source of irrigation water. Nitrogen fertilizer application rates may be reduced or eliminated if irrigation water contains elevated nitrate levels. Groundwater with nitrate concentrations in excess of the MCL of 10 mg/l is found throughout the northern parts of the Eloy and Maricopa-Stanfield subbasins. Since 1990, there were 11 exceedences of the nitrate MCL reported for water systems in the two subbasins. Figure 7-1 displays nitrate well testing data for locations within the Pinal AMA.

7.5.4.2 Sulfate

Sulfate can occur as a natural inorganic constituent of groundwater which originates from the natural dissolution of minerals in aquifers. Elevated concentrations can result from the leaching of industrial wastes and agricultural fertilizers. High sulfate concentrations are often found in aquifers underlying current or historic agricultural lands, mining areas, and areas of natural mineralization.

The EPA has not established a primary MCL for sulfate although it is currently under review. The secondary MCL for sulfate is 250 mg/l. Elevated levels of sulfate have been found in the northern parts of the Eloy and Maricopa-Stanfield subbasins. Sulfate concentrations up to 800 mg/l have been detected near Casa Grande and Coolidge, and levels of 500 mg/l have been found at Maricopa. Figure 7-2 illustrates sulfate conditions in the Pinal AMA.

Elevated sulfate concentrations in drinking water supplies can cause problems due to taste and laxative effects and can lead to scale formation in evaporative cooling systems. The diverse nature of industrial water requirements creates specific water quality needs for different industries. Some industries require very low sulfate levels while others can use water with elevated sulfate levels. Additionally, high sulfate concentrations in groundwater do not commonly limit agricultural water use.



Sample Test Results

- 113 points < MCL shown
- 36 points >= MCL shown

- Pinal AMA
- Highways and Roads
- Rivers and Streams
- CAP Canal
- Cities

Figure 7- 1

Water Quality Sample Test Results

Nitrate Nitrogen and Nitrite Plus Nitrate

0 3 6 9 12
Miles

North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Well Locations and Water Quality
Samples since 1990

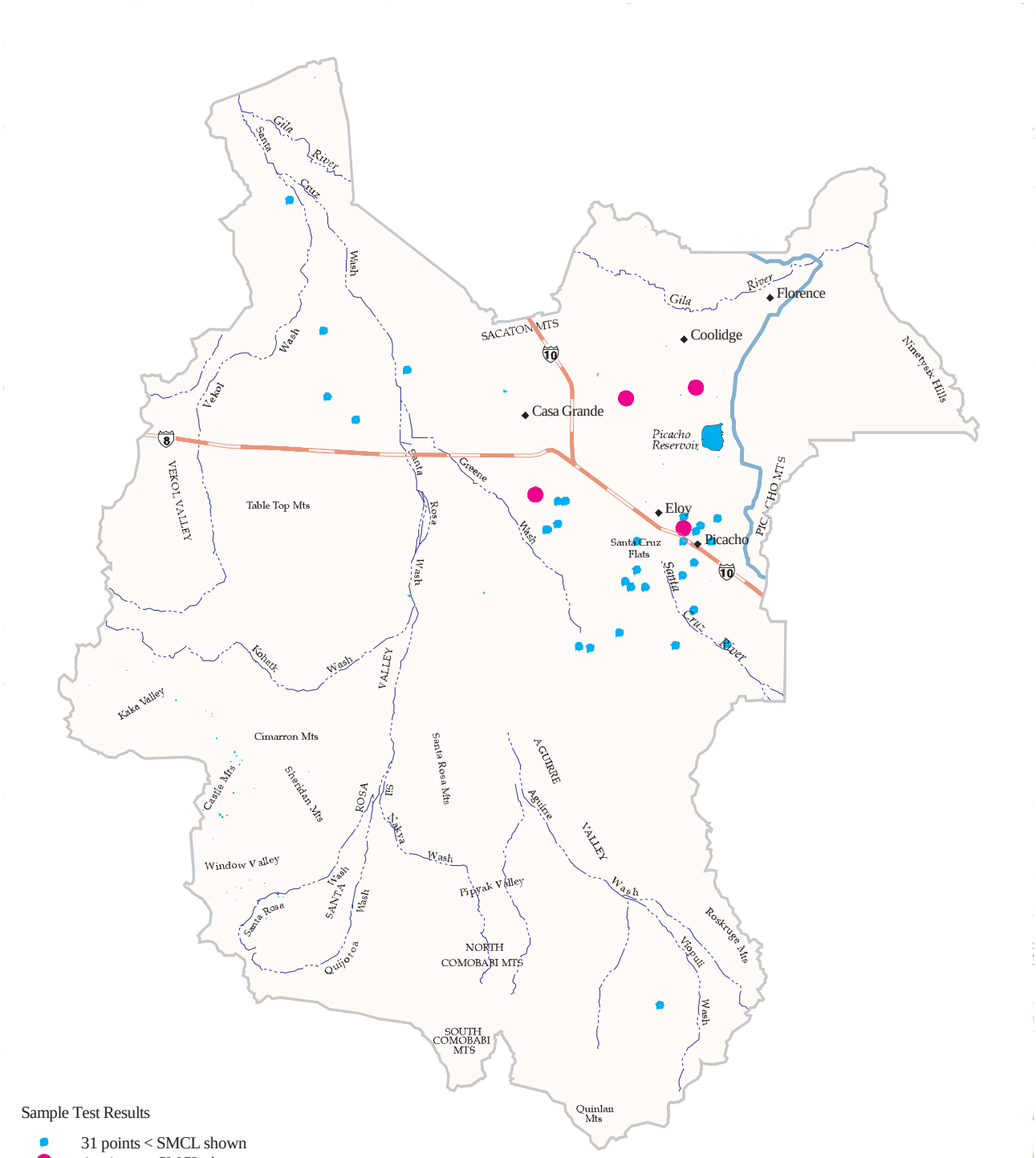


Figure 7- 2

Water Quality Sample Test Results

Sulfate

ORIGINAL SOURCE

Arizona Dept of Environmental Quality: Well Locations and Water Quality Samples since 1990

7.5.4.3 Total Dissolved Solids

TDS content is a measure of the dissolved minerals present in water and is a general indication of water quality. Components of TDS include inorganic compounds such as calcium, magnesium, sodium, potassium, sulfate, bicarbonate, chloride, and silica. In most areas, the primary components of TDS are derived naturally as groundwater dissolves minerals present in aquifers. TDS concentrations can also be elevated by agriculture, industry, and wastewater treatment facility discharges.

The EPA has established a secondary MCL of 500 mg/l for TDS, primarily for aesthetic reasons. High TDS concentrations which result in scaling and mineral accumulation have been shown to have an adverse economic impact on water distribution systems and household plumbing and appliances. Though no permanent harmful effects have been observed from drinking high TDS water, some people may find the taste of this water to be less desirable than lower TDS water.

TDS concentrations in excess of the secondary MCL of 500 mg/l have been found throughout the Pinal AMA. The highest concentrations detected are in the northern part of the Eloy and Maricopa-Stanfield subbasins, where concentrations of up to 10,000 mg/l have been found near the cities of Casa Grande, Coolidge, and Maricopa. TDS concentrations greater than 500 mg/l in the AMA are depicted in Figure 7-3. TDS concentrations less than 500 mg/l in the AMA are depicted in Figure 7-3A.

The concentration of TDS that limits water use varies widely among industries. A few industries (such as the semiconductor industry) require water so pure that they must treat almost any source water to obtain the necessary quality. Other industries, such as sand and gravel operations, can use water with very high TDS concentrations. The application of high TDS water on turf facilities can cause harmful effects to turf quality and to sprinkler heads if proper management techniques are not followed.

7.5.4.4 Metals

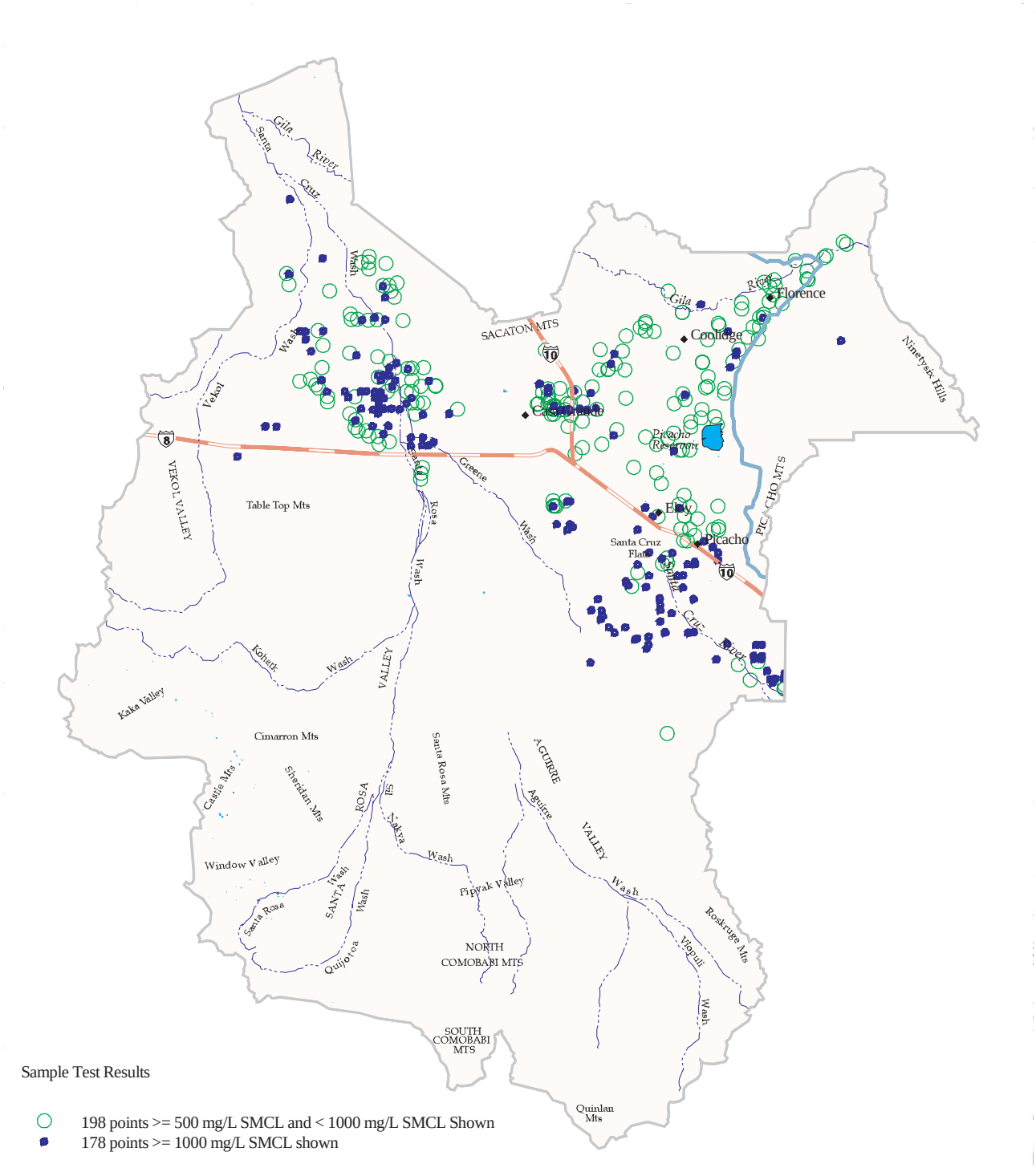
The EPA has established primary MCLs for the following nine metals that occur in drinking water: antimony, arsenic, barium, beryllium, cadmium, chromium, mercury, selenium, and thallium. High concentrations of metals are typically associated with industrial wastes, but certain metals may naturally occur in some aquifers.

While problems with metals are uncommon in the Pinal AMA, selenium has been detected at concentrations above the MCL of 50 µg/l near Eloy and Randolph. Arsenic concentrations in excess of 50 µg/l have been detected at Anegam, in the southwestern part of the AMA. Since 1990, three exceedences of the MCLs for arsenic, barium, and cadmium have been detected in water systems in the AMA. Figure 7-4 displays metal concentrations in the AMA.

The health effects associated with exposure to metals vary depending on the constituent and concentrations. Some metals such as selenium and chromium are known to be essential for human nutrition and are beneficial in certain concentrations. Others, such as lead, have no known beneficial effects on human or animal development and are harmful in high concentrations. Limitations imposed on industrial and agricultural water use by high concentrations of metals vary considerably depending on the contaminant present and the associated use.

7.5.4.5 Volatile Organic Compounds

VOCs, such as trichloroethylene and tetrachloroethylene are chemicals that evaporate easily but do not readily dissolve in water. Other VOCs include acetone, vinyl chloride, 1,2-dichloroethane, benzene, 1,1-dichloroethylene, 1,1-dichloroethane, chloroform, toluene, and methylene chloride. VOCs are present in, or are used for the manufacturing of, many substances including degreasers, solvents, plastics, paint,



Sample Test Results

- 198 points >= 500 mg/L SMCL and < 1000 mg/L SMCL Shown
- 178 points >= 1000 mg/L SMCL shown

- Pinal AMA
- Highways and Roads
- CAP Aqueduct
- Streams
- Cities

Figure 7- 3

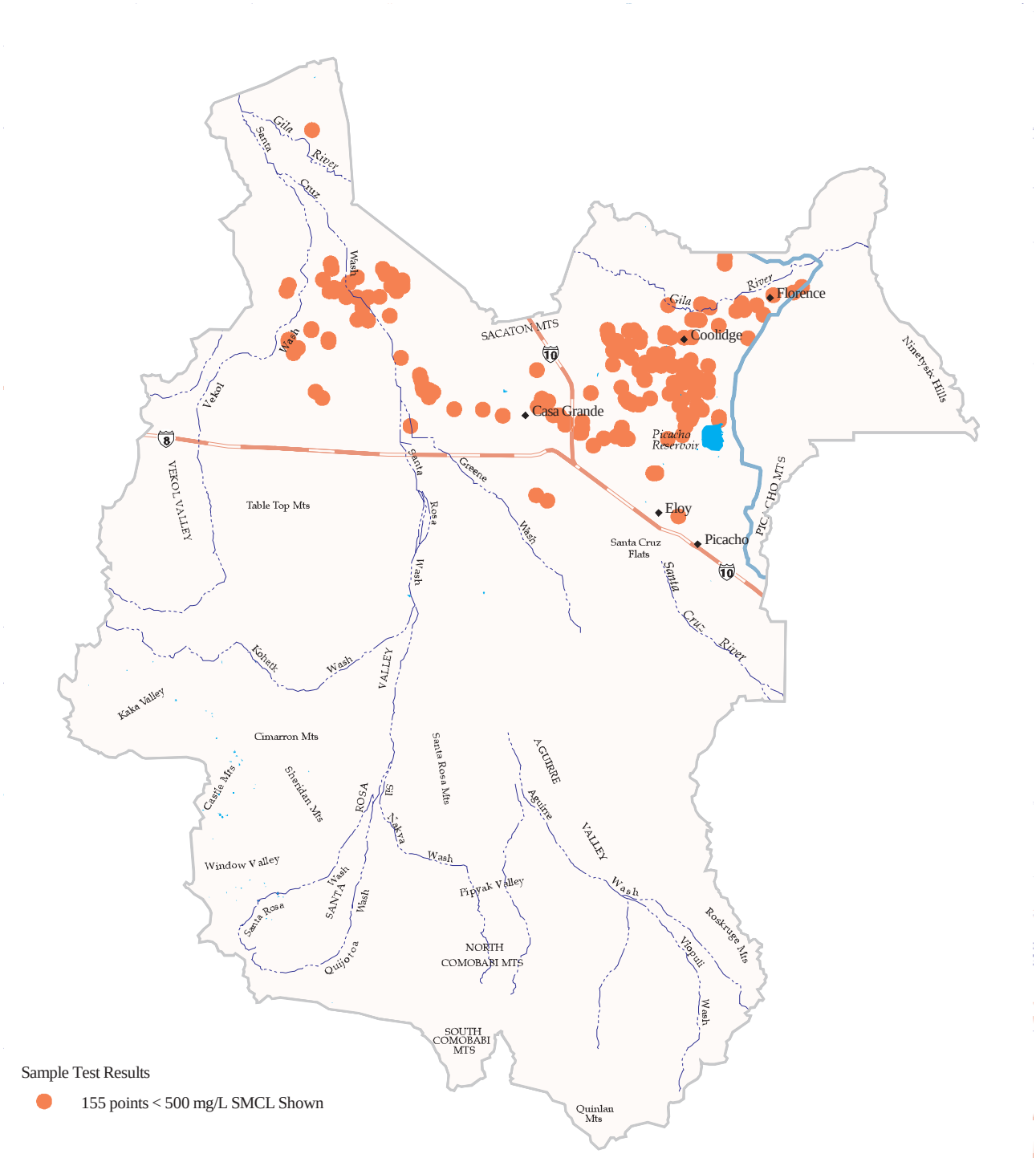
Water Quality Sample Test Results

Total Dissolved Solids

0 3 6 9 12
Miles
North

ORIGINAL SOURCE

Arizona Department of Water Resources:
GWSI Well Locations
Water Quality Samples since 1990
Calculated from Specific Conductivity



Sample Test Results

155 points < 500 mg/L SMCL Shown

Pinal AMA

Highways and Roads

CAP Aqueduct

Streams

Cities

Figure 7- 3a

Water Quality Sample Test Results

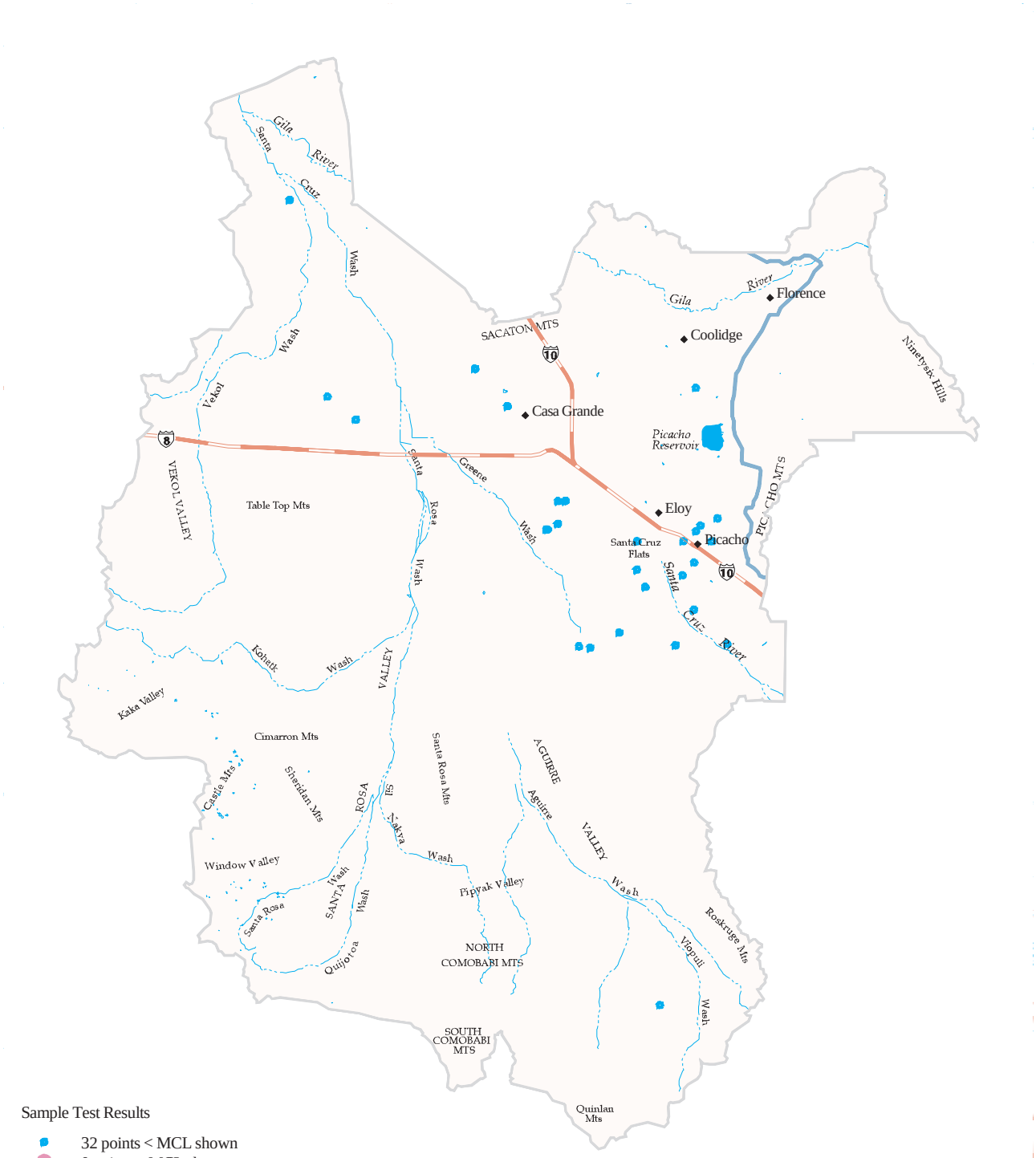
Total Dissolved Solids

0 3 6 9 12
Miles

North

ORIGINAL SOURCE

Arizona Department of Water Resources:
GWSI Well Locations
Water Quality Samples since 1990
Calculated from Specific Conductivity



Sample Test Results

- 32 points < MCL shown
- 0 points < MCL shown

Administrative Areas

- Pinal AMA
- Roads and Highways
- CAP Canal
- Rivers and Streams
- Cities

Figure 7- 4

Water Quality Sample Test Results

Metals

0 3 6 9 12
Miles

North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Well Locations and Water Quality
Samples since 1990

varnish, finish removers, detergent, medicine, and gasoline. When found in groundwater, VOCs are usually associated with industrial areas, landfills, and other sites used for the improper disposal of chemicals.

VOCs in the form of gasoline from leaking USTs have been detected in a local perched aquifer located beneath Casa Grande. Localized contamination of groundwater with trichloroethylene has also been detected in the Casa Grande area.

Health effects associated with VOCs in drinking water are complex and vary with the types of compounds and concentrations present. Some VOCs, such as trichloroethylene, are suspected human carcinogens while others have been associated with damage to internal organs. Drinking water supplies which exceed MCLs for VOCs must be treated prior to use.

Potential industrial and agricultural applications of water containing VOCs must be examined on an individual basis.

7.5.4.6 Petroleum Hydrocarbons

This class of contaminants includes non-halogenated hydrocarbons such as benzene, toluene, ethylbenzene, and xylenes, which are ingredients of gasoline and other fuels. MCLs have been established for the primary ingredients in gasoline and other fuels. These contaminants can affect groundwater as a result of, among other things, leaking USTs. According to ADEQ, there are over 5,700 leaking UST sites in Arizona. Only a small percentage of these sites are causing groundwater contamination, however, petroleum hydrocarbons may naturally attenuate over time depending on the physical, chemical, and microbiological conditions in the aquifer.

In Pinal County, approximately 113 open leaking UST facilities have been identified. The probable source of contamination at most of these locations is leaking tanks associated with gasoline stations, commercial, and industrial sites. The sites identified have varying degrees of groundwater contamination and are in various stages of remediation.

7.5.4.7 Pesticides

Pesticides are synthetic organic chemicals which are used as insecticides, rodenticides, and herbicides. One of the best known pesticides is the chemical compound 1,1,1-trichloro-2,2-bis (p-chlorophenyl) ethane, otherwise known as DDT. DDT is a water-insoluble compound that has a long residual life. DDT was used extensively until it was banned in 1973. Since 1990, there have been 4,670 groundwater samples from the Pinal AMA analyzed for pesticides. There have been no confirmed detections of pesticides in groundwater within the AMA.

The health effects of pesticide exposure in water are varied and complex, depending on both the pesticide's inert and active ingredients and reaction with substances contained in the water. Drinking water supplies can be affected by pesticide contamination. The presence of pesticides can restrict some industrial water uses such as animal-based industries because elevated concentrations of pesticides may bioaccumulate (accumulate in living tissue) as they are passed through the food chain. Pesticides that are used for agriculture can also bioaccumulate, thus restricting the use of particular chemicals on edible crops.

7.5.4.8 Fluoride

Fluorides are compounds found in rocks and soil and some industrial waste products. Fluorides are used primarily in manufacturing and as a drinking water additive for the prevention of tooth decay. Fluoride occurs naturally in groundwater; however, its potential for domestic or municipal use depends on the

concentration level. Elevated concentrations can cause mottling of teeth and skeletal effects. The EPA primary MCL for fluoride is 4.0 mg/l and the recommended secondary MCL is 2.0 to prevent mottling of teeth.

Since 1990, exceedences of the fluoride MCL have been detected in isolated groundwater wells in the Vekol Valley, Eloy, and Maricopa-Stanfield subbasins. Fluoride concentrations in the Pinal AMA are shown in Figure 7-5.

7.5.4.9 Radiochemicals

Radioactive elements such as uranium, radon, and radium occur naturally in soil and water at locations throughout Arizona. The federally proposed MCL level for radon is 300 picocuries per liter (pCi/l), but radon in groundwater is not regulated at this time. The EPA is currently collecting data on radon occurrences and conducting a health effects study prior to promulgating a radon standard for drinking water. Inhalation of radon may be harmful when it is released to the air from a contaminated water source. The primary concern of using radon-contaminated water is to ensure that the release of emissions are below air quality standards when processes such as cooling towers, construction aggregate washing and sprinkler irrigation are used.

Due to the lack of available data, groundwater quality maps depicting radiochemical concentrations were not produced for this chapter. Several radioactive elements occur naturally in soil and water. Uranium mining activities which include waste dumps and mine tailings, as well as mine dewatering, can contaminate groundwater with radiochemicals.

In the Pinal AMA, naturally occurring contaminants such as radon affect groundwater in some areas which are generally located near hardrock formations. Two exceedences of the gross alpha MCL for radium (15 pCi/l) have been recorded in water systems in the AMA.

7.5.5 Specific Contamination Areas

One WQARF site is currently listed in the Pinal AMA, a chromium disposal site associated with wastewater from industrial processes, located approximately five miles northwest of Casa Grande. Groundwater monitoring by the ADEQ is continuing at this site on a regular basis, and no impact on the groundwater beneath this site has been detected. Figure 7-6 shows the location of this WQARF site.

7.6 SUMMARY

As WQARF activities progress, addressing water management issues such as available supply and reuse options will become essential to ensure a long-term water supply of adequate quality. The ability to develop specific groundwater management strategies for preventing or rectifying potential contamination and degradation of aquifer conditions in the Pinal AMA will become increasingly important as the demands for higher quality water increase.

During the first and second management periods, ADEQ emphasized pump and treat remedies to cleanup poor quality groundwater in aquifers within the AMAs. Success was limited, however, due to lengthy periods of litigation which have seriously restricted actual cleanup activities. With the advent of the WQARF reform package of 1997, a new approach emphasizing incentives to cleanup and flexibility in the selection of remedies was developed to improve the likelihood that sites will actually become remediated.

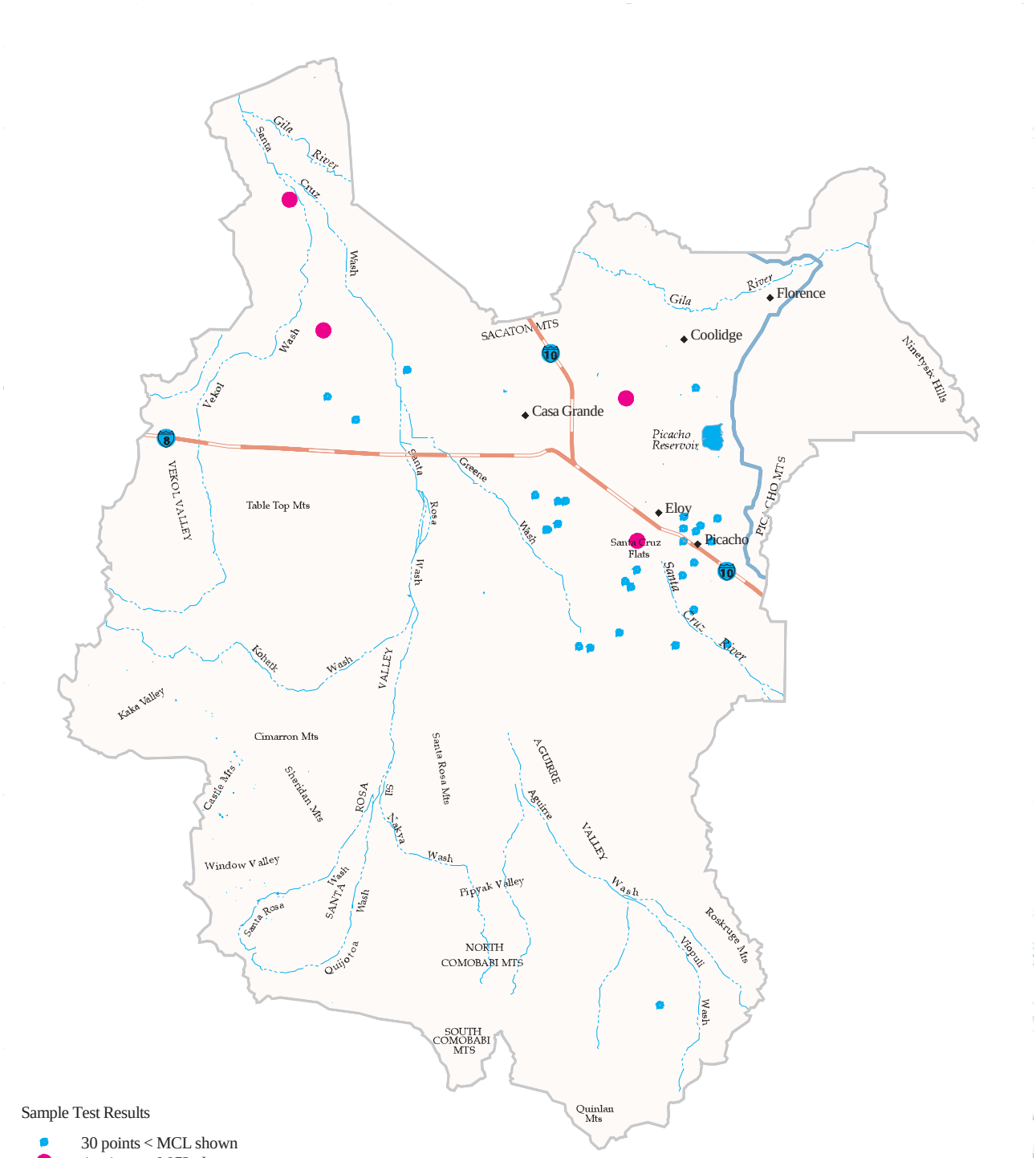


Figure 7- 5

Water Quality Sample Test Results

Fluoride

ORIGINAL SOURCE

Arizona Dept of Environmental Quality: Well Locations and Water Quality Samples since 1990

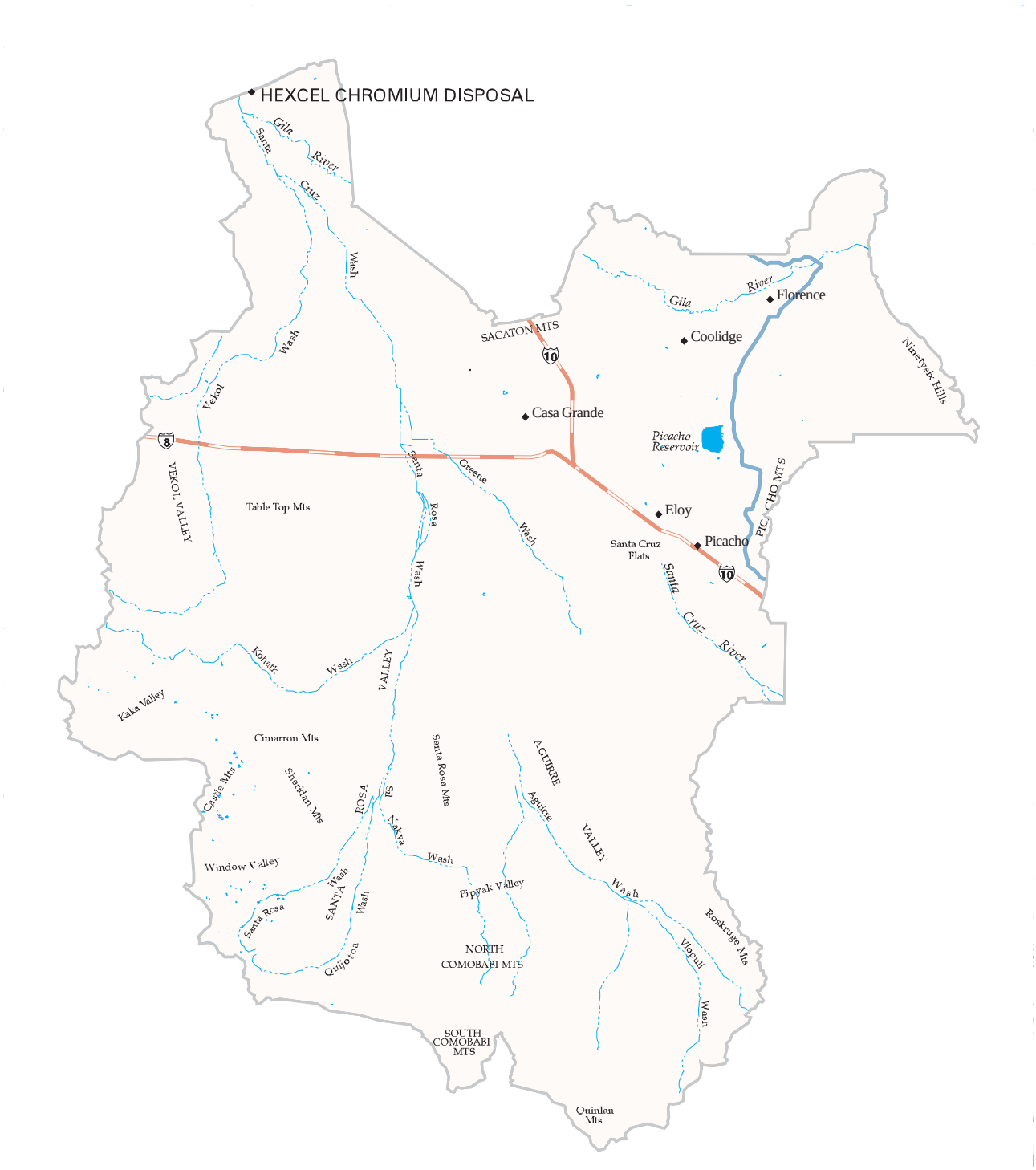


Figure 7- 6

Water Quality Study Areas

ORIGINAL SOURCE
Arizona Department of Environmental Quality
Geographic Information System

The 1997 WQARF reform legislation creates an incentive for the use of groundwater withdrawn in accordance with approved remedial action projects pursuant to Title 49, Arizona Revised Statues, or CERCLA. It provides that such groundwater must be accounted for consistent with accounting for surface water for purposed of conservation requirements, and that the use of certain volumes of such groundwater is consistent with achievement of the management goal of the AMA until the year 2025. During the third management period, the Department will amend its AWS Rules to conform to these provisions. Additionally, permanent rules regarding well spacing and impact will be promulgated by the Department during the third management period. The Department also intends to integrate water quality concerns more fully into its underground water storage programs.

During the third management period, the Department will be committed to enacting and implementing the provisions outlined in this chapter. This commitment will encompass several new provisions and activities summarized below.

- An ongoing groundwater quality assessment in cooperation with ADEQ will assist with the evaluation of existing rules and provisions.

- Integration of groundwater quality management into recharge planning and permitting and the development of incentives to use remediated groundwater where appropriate.

- Formal permit coordination with ADEQ to cooperate on both Title 45 and Title 49 permits. Basin-wide or non-site-specific tracking and coordination of all permits will provide both agencies with a more complete picture of contaminant distribution, groundwater withdrawals, and releases to groundwater and surface water on a basin-scale perspective.

- Evaluation of the need for additional incentives to withdraw and use remediated groundwater within the AMAs throughout the third management period in an effort to match quality with beneficial use. This evaluation will include groundwater that may be contaminated with hazardous, non-hazardous, and naturally occurring substances. Incentives may involve amendments to A.R.S. Title 45, Department rules and policies, or a modification of the management plans.

- The Department and ADEQ will develop and enter into Memorandums of Understanding, as necessary, to establish, among other things, the division of responsibilities for the implementation of the reformed WQARF program, development of common scopes of work for WQARF sites and other groundwater contamination sites, as well as database development and exchange.

The Department's Water Quality Section, which was established with funding provided by the 1997 WQARF reform legislation, will allow the Department to strengthen its commitment to work closely with ADEQ to resolve groundwater quantity and quality issues. Monies committed by the WQARF reform bill will expedite the cleanup of remedial sites.

Other remedial activities such as those associated with superfund sites will continue to include the Department's direct involvement. This will ensure that remedial activities are consistent, whenever possible, with the Department's water management objectives for the AMAs.

7.7 FUTURE DIRECTIONS

The Department's long-range plans for groundwater quality management will focus on two areas: (1) evaluation of groundwater quality issues on a non-site-specific level to understand the impact of broader water quality issues on groundwater resource management; and (2) preservation of AMA management goals with emphasis on implementing incentives to pump remediated groundwater.

7.7.1 Non-Site-Specific Water Quality Management

Significant volumes of groundwater in Arizona have been contaminated or degraded to varying degrees due to human activities. Groundwater contaminated with substances such as nitrate, sulfate, and dissolved solids (major cations and anions) generally result from non-point source pollution and can cause significant service problems for water providers and other water users. For example, groundwater containing high concentrations of TDS can cause scaling problems in cooling towers; it is unsuitable for use on some crops, and can cause aesthetic problems in drinking water.

The cessation or decrease of groundwater withdrawals in some areas due to groundwater quality concerns can cause water tables to rise, exposing groundwater to contaminated soils or plume migration to other wells. For example, this condition can exist when soil contaminated by a leaking UST comes in contact with rising groundwater levels. Contaminated soils associated with landfills may also be inundated by rising water tables. These conditions need to be monitored for impacts on groundwater quality. Ultimately, proper planning will ensure that the impacts of groundwater recharge projects do not contribute to the degradation of aquifer conditions.

To address and mitigate dispersed contamination over large areas, a broader management strategy is needed. Areas which may need more intensive management can include those where public supply wells have been or may be affected by contamination. For instance, areas that are in the vicinity of major population centers or agricultural areas can be affected by contamination, especially if large volumes of groundwater are pumped, creating cones of depression.

The concept of groundwater quality management on a non-site-specific scale will be developed to enhance water management activities in critical areas. The identification of source groundwater quality and the development of area-specific plans to match groundwater quality with the intended use will become an important aspect in the third management period. The Department intends to study the development of area-specific plans that could employ a combination of strategies to evaluate and mitigate the effects of contamination in critical areas. These plans should be developed in coordination with ADEQ and with affected stakeholders. Any contaminant management on a non-site-specific scale will be voluntary and will not affect rights to groundwater, well ownership, delivery responsibilities, or existing permits.

7.7.2 Preservation of AMA Management Goals

The WQARF reform package of 1997 was designed to encourage the remediation of groundwater that had limited or no use due to contamination. Pump and treat groundwater remediation activities are anticipated to increase substantially during the third management period as a result of the remediated groundwater use incentives provided in the WQARF reform package. As a result, previously unavailable sources of groundwater from contaminated areas may be put to considerable use.

Remediated groundwater withdrawals associated with WQARF, CERCLA, Department of Defense, RCRA, and voluntary site cleanups are expected to increase. However, according to estimates provided by ADEQ, it is not anticipated that the withdrawal and beneficial use of remediated groundwater will take place in the Pinal AMA during the third management period.

In the third management period, the Department will monitor water levels, subsidence, and effects on local water providers at remedial project sites in areas of intensive pumping, which generally are concentrated within the major urban centers of Arizona. While the Department supports the remediation of contaminated groundwater, it also seeks to preserve the management goal of each AMA. Water quality management is a lengthy process which will likely continue far beyond the scope of the third management period.

The net effect of continued remediated groundwater withdrawals could result in a substantial increase in the overall volume of groundwater put to use within an AMA. Without proper coordination in both water resource and groundwater quality management, remediation of contaminated groundwater could increase the AMA's groundwater overdraft by creating new groundwater uses. Remediated groundwater does not represent a renewable water supply. There are limited supplies of poor quality groundwater as well as groundwater of acceptable quality. Consequently, the Department will seek to preserve the intent of the Code and the AMA management goals to protect water resources while cooperating with ADEQ to promote groundwater quality management.

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PINAL ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Inorganics			
Antimony	0.006	Cancer	Fire retardants, ceramics, electronics, fireworks, solder
Arsenic	0.05	Skin, nervous system toxicity	Natural deposits; smelters, glass, electronics waste
Asbestos	7.0 MFL[2]	Cancer	Natural deposits, asbestos cement in water systems
Barium	2.0	Circulatory system effects	Natural deposits, pigments, epoxy sealants, spent coal
Beryllium	0.004	Bone, lung damage	Electrical, aerospace, defense industries
Cadmium	0.005	Kidney effects	Galvanized pipe corrosion; natural deposits, batteries, paints
Chromium (total)	0.1	Liver, kidney, circulatory disorders	Natural deposits; mining, electroplating, pigments
Cyanide (as free cyanide)	0.2	Thyroid, nervous system damage	Electroplating, steel, plastics, mining, fertilizer
Fluoride[3]	4.0	Skeletal and dental fluorosis	Natural deposits; fertilizer, aluminum industries
Mercury	0.002	Kidney, nervous system disorders	Crop runoff; natural deposits; batteries, electrical switches
Nickel	Remanded	Gastrointestinal distress, skin irritation, respiratory congestion	Food, water, and metal alloys
Nitrate (as N)	10.0	Methemoglobulinemia	Animal waste, fertilizer, sewage natural deposits, septic tanks
Nitrite (as N)	1.0	Methemoglobulinemia	Same as nitrate; rapidly converted to nitrate
Total nitrate/nitrite	10.0	Methemoglobulinemia	Same as nitrate; rapidly converted to nitrate
Selenium	0.05	Liver Damage	Natural deposits; mining, smelting, coal/oil combustion
Thallium	0.002	Kidney, liver, brain, intestinal	Electronics, drugs, alloys, glass

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PINAL ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Volatile Organic Chemicals			
Benzene	0.005	Cancer	Some foods; gas, drugs, paint, pesticides, plastic industries
Carbon tetrachloride	0.005	Cancer	Solvents and degradation by-products
ortho-Dichlorobenzene	0.6	Liver, kidney, blood cell damage	Paints, dyes, engine cleaning compounds, chemical wastes
para-Dichlorobenzene	0.075	Cancer	Room and water deodorants, and mothballs
1,2-Dichloroethane	0.005	Cancer	Leaded gasoline, fumigants, paints
1,1-Dichloroethylene	0.007	Cancer	Plastics, dyes, perfumes, paints
cis-1,2-Dichloroethylene	0.07	Liver, kidney, nervous, circulatory	Waste industrial extraction solvents
trans-1,2-Dichloroethylene	0.1	Liver, kidney, nervous, circulatory	Waste industrial extraction solvents
Dichloromethane	0.005	Cancer	Paint stripper, metal degreaser, propellant, extraction
1,2-Dichloropropane	0.005	Cancer, liver and kidney effects	Soil fumigant; waste industrial solvents
Ethylbenzene	0.7	Liver, kidney, nervous system	Gasoline; insecticides; chemical manufacturing wastes
Monochlorobenzene	0.1	Nervous system and liver effects	Waste solvent from metal degreasing process
Styrene	0.1	Liver, nervous system damage	Plastics, rubber, resin, drug industries; landfill leachate
Tetrachloroethylene	0.005	Cancer	Improper disposal of dry cleaning and other solvents
Toluene	1.0	Liver, kidney, nervous, circulatory	Manufacturing and solvent operations, gasoline additive
1,2,4-Trichlorobenzene	0.07	Liver, kidney damage	Herbicide production, dye carrier
1,1,1-Trichloroethane	0.2	Liver, nervous system effects	Adhesives, aerosols, textiles, paints, inks, metal degreasers
1,1,2-Trichloroethane	0.005	Kidney, liver, nervous system	Solvent in rubber, other organic products; chemical production wastes
Trichloroethlylene	0.005	Cancer	Textiles, adhesives, and metal degreasers

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PINAL ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Vinyl chloride	0.002	Cancer	May leach from PVC pipe; formed by solvent breakdown
Xylenes (total)	10.0	Liver, kidney, nervous system	By-product of gasoline refining; paints, inks, detergents
Synthetic Organic Chemicals			
Alachlor	0.002	Cancer	Runoff from herbicides applied to crops
Atrazine	0.003	Mammary gland tumors	Runoff from herbicides used on crops and non-cropland
Benzo(a)pyrene	0.0002	Cancer	Fossil fuels, burning organic matter, coal tar coatings, volcanics
Carbofuran	0.04	Nervous, reproductive system effects	Soil fumigant; some area restrictions apply
Chlordane	0.002	Cancer	Leaching from soil treatment for termites
2,4-D	0.07	Liver and kidney damage	Runoff from herbicides applied to crops, rangelands, and lawns
Dalapon	0.2	Liver and kidney effects	Herbicide on orchards, crops, lawns, road/railways
Dibromochloropropane	0.0002	Cancer	soil fumigant
Di(2-ethylhexyl)adipate	0.4	Decreased body weight	Synthetic rubber, food packaging, cosmetics
Di(2-ethylhexyl)phthalate	0.006	Cancer	PVC and other plastics
Dinoseb	0.007	Thyroid, reproductive organ damage	Runoff of herbicide from crop and non-crop applications
Diquat	0.02	Liver, kidney, eye effects	Runoff of herbicide on land and aquatic weeds
Endothall	0.1	Liver, kidney, gastrointestinal	Herbicide on crops, land/aquatic weeds; rapidly degraded
Endrin	0.002	Liver, kidney, heart damage	Pesticide on insects, rodents, birds; restricted since 1980
Ethylene dibromide	0.00005	Cancer	Leaded gasoline additives; leaching of soil fumigant
Glyphosate	0.7	Liver, kidney damage	Herbicide on grasses, weeds, brush
Heptachlor	0.0004	Cancer	Leaching of insecticide for termites and very few crops

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PINAL ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Heptachlor epoxide	0.0002	Cancer	Biodegradation of heptachlor
Hexachlorobenzene	0.001	Cancer	Pesticide production waste by-product
Hexachlorocyclopentadiene	0.05	Kidney, stomach damage	Pesticide production intermediate
Lindane	0.0002	Liver, kidney, nervous, immune circulatory	Insecticide on cattle, lumber, gardens; restricted in 1983
Methoxychlor	0.04	Growth, liver, kidney, nerve effects	Insecticide for fruits, vegetables, alfalfa, livestock, pets
Oxamyl (Vydate)	0.2	Kidney damage	Insecticide on apples, potatoes, tomatoes
Pentachlorophenol	0.001	Cancer, liver and kidney effects	Wood preservatives, herbicide, cooling tower wastes
Picloram	0.5	Kidney, liver damage	Herbicide on grass sod, some crops, aquatic algae
Polychlorinated biphenyls	0.0005	Cancer	Coolant oils from electrical transformers; plasticizers
Simazine	0.004	Cancer	Herbicide on grass sod, some crops, aquatic algae
2,3,7,8-TCDD (Dioxin)	3×10^{-8}	Cancer	Chemical production by-product; impurity in herbicides
Toxaphene	0.003	Cancer	Insecticide on cattle, cotton, soybeans; canceled in 1982
2,4,5-TP (Silvex)	0.05	Liver and kidney damage	Herbicide on crops, right-of-way, golf courses; canceled in 1983
Radionuclides			
Combined Radium-226 and Radium-228	5 pCi/l[4]	Bone Cancer	Natural deposits
Gross Alpha[5]	15 pCi/l	Cancer	Decay or radionuclides in natural deposits
Gross beta	4 mrem/yr[6]	Cancer	Decay of radionuclides in natural and man-made deposits
Radon-222 (Proposed)	300 pCi/l	Cancer	Natural sources
Uranium (Proposed)	20 µg/l[7]	Cancer	Natural sources

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PINAL ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Microbiology			
Giardia lamblia	TT[8]	Gastroenteric disease	Human and animal fecal waste
Legionella	TT	Legionnaire's disease	Indigenous to natural waters; can grow in water heating systems
Standard Plate Count	TT	Indicates water quality, effectiveness of treatment	
Total Coliform	[9]	Indicates gastroenteric pathogens	Human and animal fecal waste
Turbidity	[9]	Interferes with disinfection, filtration	Soil runoff
Viruses	TT	Gastroenteric disease	Human and animal fecal waste
Total Trihalomethanes	0.1	Cancer	Drinking water chlorination by-products

[1] mg/l = milligrams per liter (all MCLs are in mg/l unless otherwise indicated)
[2] "MFL" means million fibers per liter greater than 10 microns
[3] The MCL for fluoride applies to community water systems only
[4] pCi/l = picocuries per liter (30pCi/l is equivalent to 20 µg/l)
[5] Gross particle activity, including Radium-226 but excluding Radon and Uranium
[6] mrem/yr = millirem per year, see ADEQ, Drinking Water Rules source (1) for more information
[7] µg/l = micrograms per liter
[8] Treatment Technology (refer to source (1) for more information)
[9] Refer to source (1) for more information

Sources:

Arizona Department of Environmental Quality, Arizona Drinking Water Rules, April 28, 1995
United States Environmental Protection Agency, Office of Water 4304, EPA 822-B-96-002, October 1996
United States Environmental Protection Agency, National Primary Drinking Water Regulations, Appendix A: National Primary Drinking Water Standards (Modified 1/14/98)

APPENDIX 7B
SECONDARY DRINKING WATER STANDARDS[1]
PINAL ACTIVE MANAGEMENT AREA

Contaminants	SMCLs (mg/l)[2]
Aluminum	0.05 to 0.2
Chloride	250
Color	15 color units
Copper	1.0
Corrosivity	non-corrosive
Fluoride	2.0
Foaming agents	0.5
Iron	0.3
Manganese	0.05
Odor	3 threshold odor numbers
pH	6.5 - 8.5
Silver	0.1
Sulfate	250
Total dissolved solids	500
Zinc	5

[1] Secondary Drinking Water Standards are unenforceable federal guidelines regarding taste, odor, color and certain other non-aesthetic effects of drinking water. States may adopt their own enforceable regulations governing these concerns.

[2] Secondary Maximum Contaminant Levels (SMCLs) units are in milligrams per liter (mg/l) unless otherwise indicated.

Source: United States Environment Protection Agency, Office of Water 4304, EPA 822-B-96-002, October 1996.